U.S. Army Research Institute
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Measures of Platoon Leader Situation Awareness in Virtual Decision-Making Exercises

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14. ABSTRACT *(Maximum 200 words)*:

This report documents an effort to investigate the situation awareness (SA) requirements for platoon leaders in a Military Operations on Urbanized Terrain (MOUT) environment. Subject matter experts with extensive infantry experience participated in a goal-directed task analysis to identify the SA requirements of platoon leaders at three levels: Level 1–perception, Level 2–comprehension, and Level 3–projection. From this analysis, objective and subjective SA measurement instruments were developed. Experienced and inexperienced officers engaged in four simulated missions in the Squad Synthetic Environment and responded to questions during halts in the simulation. Two instruments, the Situation Awareness Global Assessment Technique (SAGAT), a PC-based objective family of queries, and the Situation Awareness Behaviorally Anchored Rating Scale (SABARS), a subjective observer-rated instrument, both showed sensitivity to experience levels. The SAGAT scales also displayed sensitivity to the type of scenario and the point in the simulated mission at which the halt occurred. Officers with greater experience attended more to information about enemy locations and strengths, while less experienced officers attended more to information concerning friendly strengths. This has some intriguing implications for training new officers, but further investigation of these SA findings is necessary.

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FOREWORD

The Infantry Forces Research Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences conducts research to investigate the challenges presented by the 21st Century battlefield. Force modernization efforts must be guided by research to identify those systems and procedures that can produce the greatest benefits for U.S. forces now and in the future.

This study investigated the situation awareness (SA) of platoon leaders in simulated MOUT (Military Operations on Urbanized Terrain) missions. Since information availability and usage are integral to the development of situational dominance for any military force, identification of the multidimensional elements that comprise a soldier's SA is a critical first step in developing technologies and training methods to improve SA. A preliminary analysis of platoon leaders' SA requirements formed the basis for developing measures to quantify SA in Infantry exercises. Three instruments were developed, providing both objective and subjective SA measures which were then implemented during simulated MOUT missions.

The investigation established that SA could be quantified and measured in a light Infantry MOUT environment, despite the complexities of the information demands. The results demonstrated the utility of virtual exercises in the Squad Synthetic Environment to support both research and training. Not only were SA differences identified between experience levels, but also between scenarios and the point in the simulation at which they were queried, providing an initial demonstration of the sensitivity of the measures. Qualitative and quantitative SA differences between more experienced and less experienced officers suggest it may be possible to train less experienced officers to attend to the available information differently, thus enhancing both SA and decision-making while improving the cost-effectiveness of leader training. Critical aspects of the research were briefed to the Chief of the Dismounted Battlespace Battle Lab (DBBL) Simulation Center on 14 November 2000 and to the Deputy Director of the DBBL on 17 April 2001.

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Technical Director

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MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION-MAKING EXERCISES

EXECUTIVE SUMMARY

Research Requirements:

As the Army moves to exploit information age technology, Infantry forces will be called upon to gather information and achieve situational dominance in an increasingly complex environment. Superior situation awareness (SA), in terms of the warfighter's ability to access and use available information to improve lethality, survivability, and communication, will be a pivotal factor in the ability of the Infantry force to meet this challenge. The challenges of Military Operations on Urbanized Terrain (MOUT) contribute to the complexity of the task of Infantry forces, through the effects of a three dimensional, non-linear battlefield, a poorly defined enemy, an unpredictable and volatile civilian presence, and restrictive Rules of Engagement (ROE). In this complex environment, the systematic measurement of SA will promote better understanding of the specific information requirements of warfighters, and yield vital insights regarding the techniques used by Infantry leaders to enhance SA, and ultimately decision-making and action.

Infantry platoon leaders operate in a complex environment requiring that they attend to multiple information sources, prioritize among competing and sometimes conflicting goals, and make rapid decisions, all under highly stressful conditions where the loss of life, either their own or others', is a constant threat. To complicate the matter, platoon leaders are often relatively inexperienced officers, with minimal service time, training and experience to draw on. In this environment, superior SA provides tremendous advantages to those with the ability to acquire it and the experience to use it.

Procedure:

The current project focused on three distinct functional goals. The first phase involved an SA requirements analysis identifying elemental factors essential for the development of superior SA by platoon leaders in a MOUT mission. Infantry subject matter experts assisted in a goal-directed task analysis to identify the SA requirements. The second phase involved development of objective and subjective SA measures to support research of Infantry leaders' SA during MOUT exercises in the Squad Synthetic Environment, a virtual simulation. The third and final phase entailed implementation of these measures in four separate simulated MOUT missions to determine whether the measures could reveal SA differences, both between scenarios and within a scenario at different times. Perhaps most important, the virtual investigation explored differences between the level and type of SA in experienced and inexperienced platoon leaders.

By identifying characteristic differences in the processing of SA information with experience, it may be possible to identify training methods that can increase the efficiency and

effectiveness of training less experienced platoon leaders to see the patterns and threats that are more apparent to officers with higher levels of experience. This would provide the double benefit of maximizing training value while decreasing the training time required to produce officers who are better prepared for the battlefield.

Findings:

Despite a small sample size, data analysis revealed several findings of interest. First, experienced officers were better at locating both friendly and enemy elements on a map. Second, more experienced officers focused their attention on the enemy to a greater degree than less experienced officers, so that they had a better understanding of the enemy strengths and the threat posed, while less experienced officers better understood friendly strengths. While further research is needed, this finding could have significance for developing training methods. Third, the objective SA measures demonstrated sensitivity to experience level, type of scenario, and point in the simulation at which the measures were taken, providing preliminary indications of their utility for the study of SA under the unique conditions encountered in Infantry operations.

The investigation established that SA could be quantified and measured in a light Infantry MOUT environment, despite the complexities of the information demands. The results demonstrated the utility of virtual exercises in the Squad Synthetic Environment for both research and training. The accuracy differences identified between experience levels, scenarios and measurement halts provide an initial demonstration of the sensitivity of the SA measures.

Utilization of findings:

The SA measures developed here can be used in follow-on research to delve more deeply into the construct of SA in the light Infantry environment. Additional research can test these measures both in simulations and in live training environments. The finding that more experienced officers have a better understanding of the locations of both enemy elements and their own platoon members, and the implication of this information, can be used to train less experienced officers to focus on key information. Further, the finding that more experienced officers are better at identifying both the highest enemy threat and the strongest enemy location shows an increase in situation comprehension in these areas. By focusing on the ways in which SA changes with experience, it may be possible to train less experienced officers to attend to the available information differently. Trainers could develop instructional techniques to improve SA accordingly, focusing on the development of a mindset that constantly considers what the enemy will do next. Such advances would enhance both SA and decision-making while improving the cost-effectiveness of leader training.

MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION-MAKING EXERCISES

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MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION-MAKING EXERCISES

Introduction

Situation awareness (SA), knowing what is going on in the situation around you, is a fundamental requirement for combat success. It forms the foundation for military decision-making and task execution. In the demanding Infantry combat environment, superior SA brings tremendous advantages by promoting information dominance, improving security and survivability, and optimizing lethality. The future battlefield calls for advanced technologies, leader development, and training concepts targeted at enhancing SA at all echelons. These goals can only be achieved through systematic effort and knowledge regarding SA. As Infantry forces apply technological advances to expand battlefield information flow, it becomes increasingly important to understand the factors shaping SA in Infantry operations, to include the interrelationships among those factors. Experience has proven that more information does not necessarily produce better SA or improve situational dominance. The development of training programs and technologies that enable employment of forces with high levels of SA depends upon a solid foundation of knowledge regarding SA in the Infantry arena.

The Challenge of Situation Awareness in Infantry Platoon Operations

Endsley, Holder, Leibrecht, Garland, Wampler and Matthews (2000) provide an analysis of the role of SA in Infantry operations. Infantry platoon leaders decide how they will deploy, orient, and direct their squads based on their mission, situation and SA. Achieving high levels of SA in the highly complex and dynamic environment is not easy. Many stressors act to degrade the platoon leader's SA, or to prevent him from gaining a high level of SA to begin with. Time pressure and the rapid tempo of operations can significantly challenge platoon leaders who often must struggle to maintain an up-to-date awareness of a rapidly changing reality. The conditions for gathering and assimilating information may rapidly deteriorate during combat operations.

Fatigue brought on by heavy physical exertion, lack of sleep and nighttime operations also degrade the platoon leader's ability to detect and process information vital to good SA. Poor environmental conditions, including noise, fog, weather, and smoke can directly obscure critical information. Stress and anxiety associated with warfare and the inherent uncertainty and confusion can all act to reduce SA (Endsley et al., 2000). Periods of significant task underload or task overload can also lead to SA problems.

The factors that shape SA also can be greatly influenced by the enemy, who can alter the tempo of the battle and dramatically affect the conditions under which a battle is fought. Thus, Infantry operations frequently must be conducted under the challenges of a number of factors, some naturally occurring, some task or enemy induced, that can all act to seriously degrade SA.

Situation Awareness in Infantry Operations

Endsley (1988) formally defined SA as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the

projection of their status in the near future" (p. 97). This mental representation of the state of the world involves perceiving critical factors in the environment (Level 1 SA), comprehending what those factors mean (Level 2 SA), particularly when integrated in relation to the soldier's goals, and at the highest level, projecting what will happen in the near future (Level 3 SA). The higher levels of SA allow soldiers to function in a timely and effective manner. These three levels are depicted in Figure 1, and will be described further.

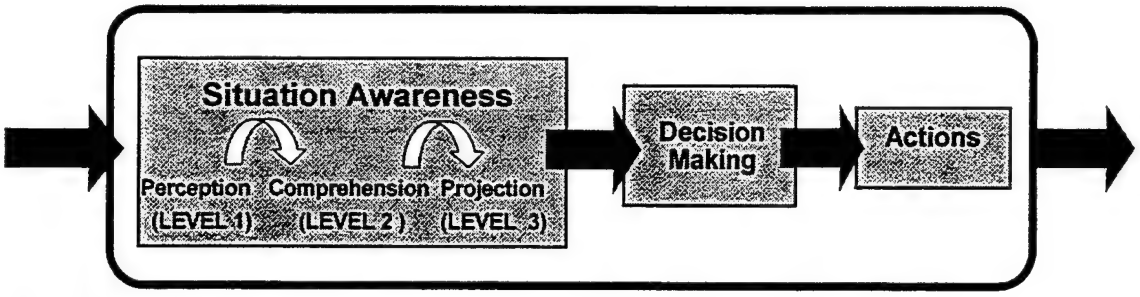

Figure 1. Model of situation awareness levels and decision-action process (from Endsley et al., 2000).

Level 1 Situation Awareness—Perception of the Elements in the Environment

Achieving SA begins with perceiving the status, attributes, and dynamics of relevant elements in the environment. Important elements include the position and actions of friendly forces, enemy forces, and civilians; terrain features; obstacles; and weather. In Infantry operations factors such as noise, smoke, confusion and the dynamics of a rapidly changing situation may often obscure critical elements of the situation. Numerous sources of information compete for the platoon leader's limited attention and mental processing resources. The platoon leader can obtain information from direct observation of the environment, from verbal and non-verbal communication with others, or from electronic systems and sensors. Each source of information may carry its own level of reliability. Confidence in information (based on past experience with the system, organization, or individual providing it) forms a critical part of Level 1 SA for the Infantry platoon leader.

Level 2 Situation Awareness—Comprehension of the Current Situation

The platoon leader's comprehension of the situation stems from a synthesis of disjointed Level 1 elements. Level 2 SA extends to an understanding of the significance of the information that is present, in the context of the platoon leader's goals. The platoon leader integrates Level 1 data to form a holistic picture of his environment, including a comprehension of the significance of objects and events. For example, upon seeing the impression of a certain type of vehicle track in soft ground, an experienced leader may realize that enemy units have passed through the area and consequently adopt a stealthier posture. A less experienced leader may see the same cues (Level 1 SA), but not be able to understand their meaning as well. The platoon leader typically interprets Level 1 SA (perceived data) with reference to his goals or plans in order to build Level 2 SA.

Level 3 Situation Awareness—Projection of Future Status

At the highest level of SA, the platoon leader is able to predict or project the future actions of the elements in the environment, at least for the very near term. He accomplishes this by combining knowledge of the status and dynamics of the elements with comprehension of the situation (Level 1 and Level 2 SA). Platoon leaders with a high level of SA are able to anticipate where and when the enemy will strike. They can estimate how much time they have until reinforcements arrive or until supporting fires can be delivered on a target. This look-ahead capability gives them the knowledge and time necessary to decide on the most favorable course of action to meet their objectives and goals.

Differences in Abilities Required to Develop Situation Awareness Among Individuals

In addition to the problems that the battlefield environment poses on the development of SA, significant individual differences exist in the degree to which people are able to detect and assimilate information to form a coherent and complete picture of the situation. While this issue has not been studied in detail in Infantry operations, as much as a tenfold difference in SA abilities has been reported among trained individuals in other domains. Anecdotal information would suggest that individual differences likely exist in those involved in Infantry operations as well. These SA abilities have been found to be highly stable within individuals (Endsley & Bolstad, 1994).

A number of factors most likely contribute to individual differences in SA ability (Endsley et al., 2000). Some may involve basic capabilities, such as pattern matching skills, perceptual speed, spatial ability, and attention sharing. At the same time, significant advantages in SA can be gained through training and experience in the warfighting environment. Training and experience allow leaders to develop mental models and relevant memory stores that provide rapid real-time pattern matching of perceived information to form the highest levels of SA. These memory structures make it possible for an individual to understand what information is important, how to direct one's attention to maximum advantage, and how to correctly interpret and integrate the information that is perceived. Under the strain of battlefield conditions, these capabilities are decisive in allowing Infantry soldiers and leaders to gain and maintain SA.

Improving the SA skills of Infantry leaders offers potential payoff in combat effectiveness. Little detailed information is currently available about how SA differs among Infantry leaders as they gain experience and knowledge, however. Because SA itself has not been studied in detail in the Infantry environment, little is known about what factors allow highly successful leaders to quickly gain and maintain high levels of SA, or how well this issue differentiates those leaders from others. By better understanding the processes, skills and knowledge associated with high (and low) levels of SA in Infantry operations, training programs that are more carefully focused on enhancing SA skills can be created to help inexperienced officers more quickly achieve higher levels of both SA and performance. Examining the ways in which SA differs between experienced and inexperienced Infantry officers forms one goal of the present research.

Evaluating Situation Awareness in Infantry Operations

Future research on the nature of SA in Infantry operations and the development and validation of training programs or new technologies depends upon the development and validation of measures of SA for Infantry operations. "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind" (Lord Kelvin, quoted in Bartlett & Kaplan, 1992, p. 504).

By carefully examining the SA developing behaviors of experienced and inexperienced Infantry officers and measuring the level of SA, we may be able to gain insight into the ways in which warfighters can form SA under challenging conditions.

Situation Awareness Measurement Techniques

Measures of SA can be classified into four broad types (Endsley et al., 2000):

- Process indices–which examine how individuals acquire and process cues available in their environment. These process indices may be obtained using devices such as eye trackers or by studying communication patterns,
- Direct measures of SA–including purely subjective measures such as self-ratings or observer ratings, and more objective measures of SA which compare an individual's reported perceptions of the environment to some "ground truth" reality,
- Behavioral measures of SA–which try to infer SA from the actions that individuals choose to take, based on the assumption that good actions will follow from good SA and vice-versa; and
- Performance measures of SA–which try to infer SA from the end result, based on the assumption that if more kills are scored, for instance, SA must have been higher.

The pros and cons of these general measurement approaches and their applicability to Infantry operations are outlined in Endsley et al. (2000). For the purposes of the present research, we concentrated on developing and validating more direct measures of SA. Aside from the fact that other more inferred measures of SA are fairly circular in logic and therefore of little direct use in developing an understanding of SA in Infantry operations, more direct measures of SA can provide far more detail about the SA construct itself. That detail is needed to develop new training methods. Direct measures of SA include both subjective and objective measurement techniques.

Objective Measures of Situation Awareness

The most widely used approach to objectively measuring SA is the Situation Awareness Global Assessment Technique (SAGAT) (Endsley, 1988, 1995). Using SAGAT, a simulated exercise is halted at randomly selected times, information sources (e.g., communication channels, virtual displays, or new information technologies) are blanked and the exercise is suspended while participants quickly answer questions about their current perceptions and understanding of the situation. Participant perceptions can then be compared to the real situation

(as determined by simulation computer data or experienced observers who have knowledge about the actual state of events) to provide an objective measure of SA. By collecting SA data in this manner, SAGAT provides an objective, unbiased assessment of SA. This method provides a tool capable of measuring SA across all three levels, based on a comprehensive analysis of domain-specific SA requirements (Endsley et al., 2000).

In other domains such as piloting high performance aircraft, SAGAT has regularly yielded a high degree of validity (Endsley et al., 2000). It has good predictive validity, with SAGAT scores indicative of pilot performance in a combat simulation (Endsley, 1990a). Content validity was also established, showing the SAGAT queries to be relevant to SA in a fighter aircraft domain (Endsley, 1990b). A number of studies have demonstrated no noticeable impact on performance associated with inserting the freezes to collect SA data via SAGAT (Endsley, 1995, 2000). New queries (detailing each of the critical aspects of the situation that the Infantry leader or soldier can be asked to report upon during a "halt") need to be established for the Infantry domain, however, to make this approach viable for studying SA in Infantrymen.

Subjective Measures of Situation Awareness

An easy to administer method for measuring SA is to ask exercise participants to provide a rating of their own SA. Alternatively, skilled observers may be asked to provide a rating of the SA possessed by the exercise participants. While subjective ratings are simple and direct, they also have several limitations. Individuals making subjective assessments of their own SA have no objective basis for their judgments. They may not know what they do not know (e.g., there may be an enemy just over the next hill waiting to ambush them). Such subjective measures also tend to be global in nature, and as such do not provide the detailed diagnostic resolution that is available with objective measures.

Subjective self-assessments of SA have been found to be poorly related to objective measures of SA (Endsley & Selcon, 1997). Nonetheless, a person's subjective level of SA may be important for determining how he will act. Those with the belief that they have good SA may be more likely to act upon that knowledge (to either good or ill effect, depending on the accuracy of that belief), and those who believe their SA to be poor may be less likely to act (either wisely or unwisely) (Christ, McKeever, & Huff, 1994). The Situation Awareness Rating Technique (SART), the most commonly used subjective measure of SA, also incorporates workload assessments that are inappropriate for the Infantry domain. Therefore, we sought to develop a simple subjective self-rating measure of SA for this effort.

Observer ratings may be slightly better than self-ratings because more information about the true state of the environment is usually available to the observer than to the mission participants. However, observers tend to have less insight into the mental state of the person being evaluated and are forced to rely more on observable actions and verbalizations of the participants to infer the person's level of SA. One means for minimizing this difficulty is to ask observers to evaluate the degree to which individuals are carrying out actions and exhibiting behaviors that should promote the achievement of high levels of SA. This approach removes some of the subjectivity associated with making judgments about someone's internal state of

knowledge and allows them to make judgments about things that are more readily observable. In the current effort we sought to develop a behaviorally anchored rating scale for this purpose.

Study Objectives

The present research is an exploratory effort conducted within a virtual battlefield simulation—the Squad Synthetic Environment (SSE)—at the platoon level. The research had several main objectives:

1. To develop an understanding of the specific factors that are important for SA at the level of the platoon leader,
2. To develop objective and subjective measures for studying SA in platoon leaders and to conduct a preliminary evaluation of their utility and validity, and
3. To explore the quantitative and qualitative ways in which SA differs between experienced and inexperienced platoon leaders using these measures.

These objectives were accomplished in three phases:

- Phase 1: Situation Awareness Requirements Analysis
- Phase 2: Situation Awareness Measures Development
- Phase 3: Soldier-in-the-Loop Investigation.

Phase 1: Situation Awareness Requirements Analysis

Overview

The SA requirements analysis was performed as a goal-directed task analysis following the methodology of Endsley (1993) and Endsley and Rodgers (1994). The SA requirements were defined as those dynamic information needs associated with the major goals or sub-goals of the platoon leader in performing his job in a MOUT (Military Operations on Urbanized Terrain) mission. To accomplish the analysis, the major primary and secondary goals of the mission were identified, along with the major subgoals necessary for meeting each goal. Associated with each subgoal, the major decisions facing the platoon leader were identified. The SA requirements for making these decisions and carrying out each subgoal were then identified. These requirements focused not only on what information the platoon leader needs, but also on how that information is integrated or combined to support each decision.

Several considerations need to be mentioned in relation to the SA requirements analysis:

1. At any given time more than one goal or subgoal may be operational, although they may not have the same priority. The analysis does not assume any prioritization among the goals, or that each subgoal within a goal will always be active.
2. The analysis was based on goals or objectives, not tasks. The analysts strove to be as technology-free as possible. How the information is acquired was not addressed. It could be through direct observation, verbal communication, new technology, or cognitive processing by the platoon leader of new or previously acquired information.

Many of the higher-level SA requirements fall into the latter category. The way in which information is acquired can vary widely between individuals, over time, and between situations.

3. The analysis sought to determine what platoon leaders would ideally like to know to meet each goal. It was recognized that they often must operate on the basis of incomplete information and that some desired information may not be available at all.
4. Static knowledge, such as doctrine, procedures or rules of engagement (ROE), was outside the bounds of this analysis. The method focused only on dynamic situational information affecting what the platoon leader does.

Method

Source of Input

Six male Infantry subject matter experts (SMEs), three active duty and three retired commissioned officers, assisted in initial knowledge elicitation sessions using the goal-directed task analysis methodology (Endsley, 1993; Endsley & Rodgers, 1994). The SMEs participated in one intensive individual interview session each, lasting approximately two hours. One of the six, an active duty field grade officer, collaborated in a final review of the goal hierarchy developed from earlier sessions.

Procedure

Each SME responded to a series of open-ended questions by the authors designed to elicit detailed responses concerning doctrinally-based goals and the decisions associated with the accomplishment of those goals. The SME then addressed the information needed to formulate these decisions. Interviewers held their questions until the SME reached a natural stop in his narrative response, so as not to interrupt the flow of ideas. At this time, particular care was taken to ascertain exactly how each piece of information was used. Higher-level assessments related to comprehension and projection were determined in this manner.

The six initial interviews were scheduled two per day, with at least a one week interval between interview dates to allow interviewers to review the data, break it down and reorganize it, identifying knowledge gaps to be filled in during the next scheduled sessions. After the first two complete interview sessions, SMEs viewed a graphical representation of a preliminary goal hierarchy developed from data collected in the early sessions, coupled with a review of the available literature in the field of Infantry SA. SMEs examined the outline with a view to developing consensus and identifying gaps in the analysis. This process continued through three iterations, including review of the first draft of the completed document, until SMEs were in general agreement with the analysis. A field grade SME with research experience performed a final review and refinement of the completed goal hierarchy.

Results

The detailed results of the complete goal-directed task analysis can be found in Appendix A. Figure 2 shows the overall goal hierarchy structure of the analysis, with Attack, Secure and

Hold Terrain shown as the overarching objective. While this is not the precise overarching objective of every MOUT mission, an overwhelming majority of mission goals would fit beneath that umbrella. One of the main thrusts of this research was to develop SA requirements and measures applicable across a broad range of operational parameters.

The overarching objective (Attack, Secure and Hold Terrain) was partitioned into seven primary goals, where the priority of individual goals varies across missions and even across the course of a mission. The seven primary goals are:

- Avoid Casualties
- Negate Enemy Threat
- Movement: Reach Point X by Time Y
- Assault Through Objective
- Hold Objective
- Provide Stability and Support Operations (SASO)
- Function in a Team Environment

Listed under each of these seven primary goals are the secondary goals, which are often employed to meet the mission objectives. Each secondary goal shown in Figure 2 is listed on a separate page in the detailed results of the requirements analysis (Appendix A), broken down into subgoals. For each subgoal, some of the questions that the platoon leader is considering are listed, followed by the SA elements necessary to answer these questions.

To facilitate a discussion of the requirements analysis format, Figure 3 illustrates the SA requirements for secondary goal 1.1—Avoid enemy detection. This secondary goal is partitioned into three subgoals: 1.1.1—Project enemy behavior, 1.1.2—Avoid danger areas, and 1.1.3—Utilize available cover and concealment. All three of these subgoals might come into play during the operation of other goals, and they might occur at times when the secondary goal here, Avoid enemy detection, is either impossible or undesirable. For instance, if the enemy already knows the platoon's location, the platoon leader will still want to project what the enemy's behavior might be, avoid danger areas, and utilize any available cover and concealment. Thus, when these subgoals are listed in later parts of the analysis, they are listed under the secondary goal of interest, assigned a new number connecting the subgoal to the secondary goal, but the questions and SA requirements are not repeated. The original identification number for the subgoal is used to refer the reader to these listings of questions and SA requirements. For example, under secondary goal 5.1—Prepare for enemy counterattack, is a listing for subgoal 5.1.5—Project enemy behavior (1.1.1), showing the reference back to the secondary goal where this subgoal is delineated.

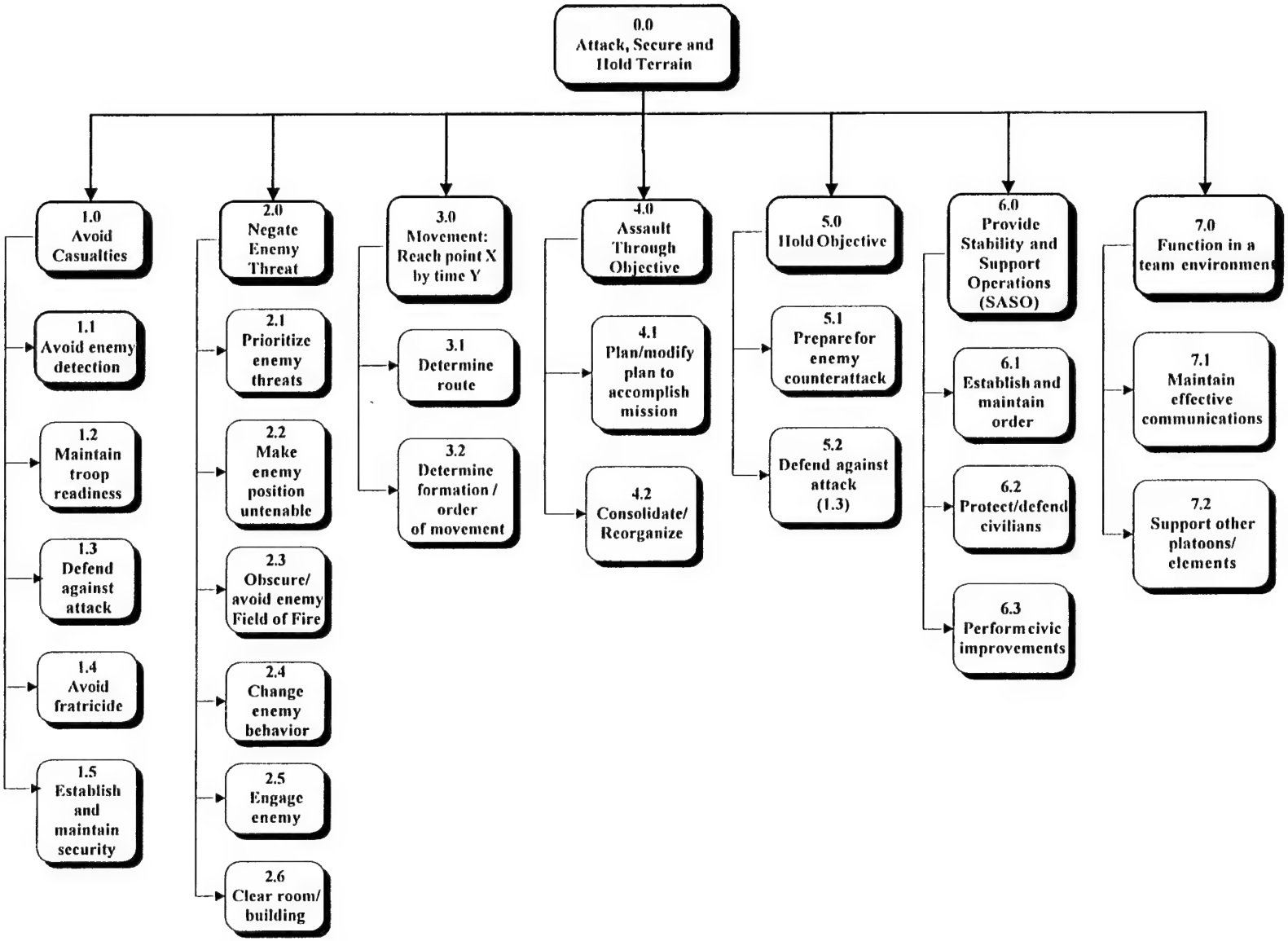

Figure 2. SA requirements analysis: primary goal structure.

As shown in Figure 3, the bottom box in each column lists the areas of SA needed to answer the questions and meet the goal in the boxes above it. If a complete set of SA requirements from another goal is needed to meet the current goal, the original goal is listed in the SA requirements in bold font, which refers the reader to a complete listing of SA requirements.

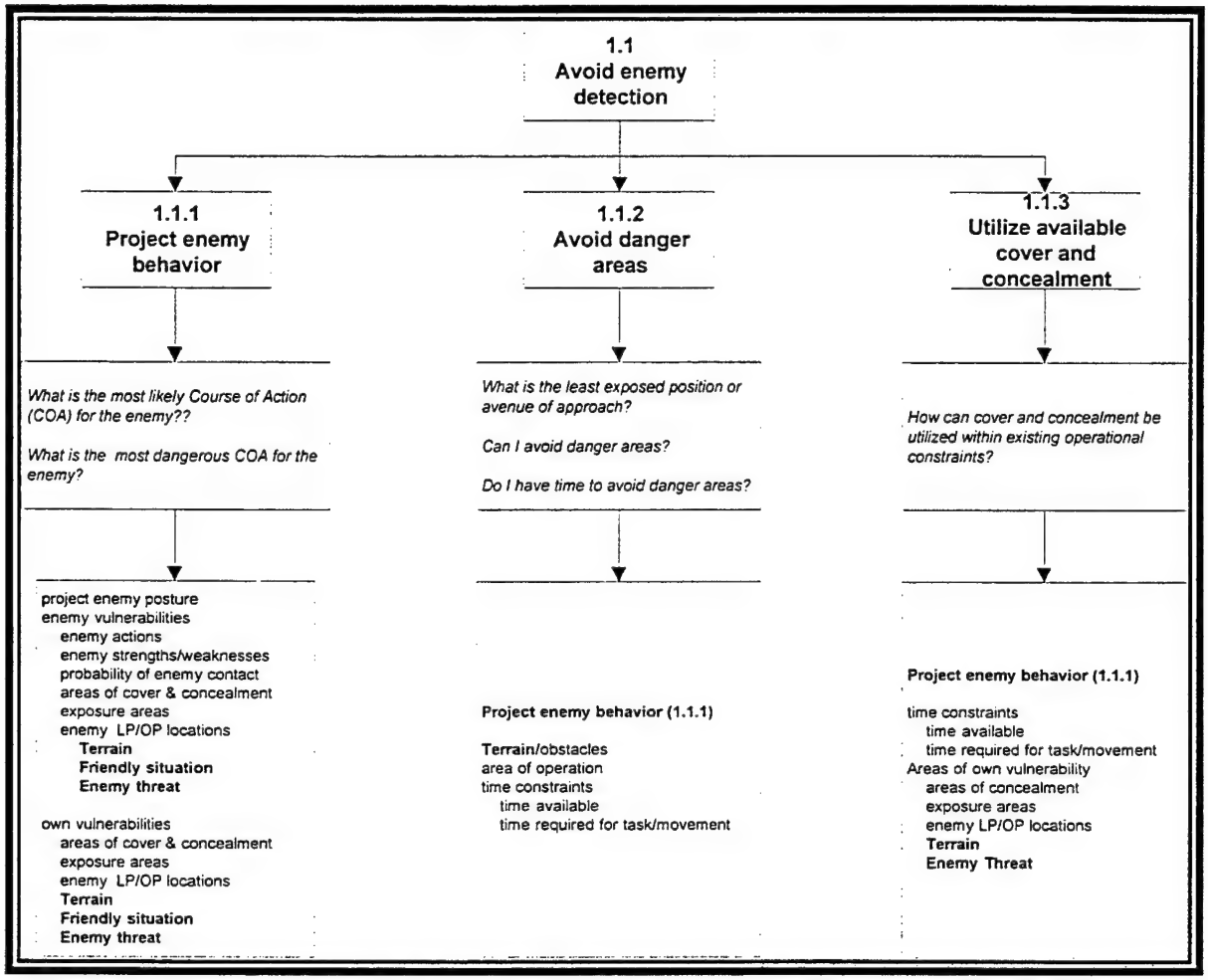

Figure 3. Example from SA requirements analysis: Secondary goal 1.1—Avoid enemy detection.

Many SA elements come into play in very diverse settings and goals, and to list them individually under each subgoal would be redundant. Instead, these often required information requirements are listed separately in categories on the final page of the analysis. Where these items are called upon in other pages of the analysis, they are also shown in bold letters. For example, certain elements of the Friendly Situation play into virtually every decision made by the platoon leader, such as the Commander's Intent and the unit mission.

Figure 4 summarizes the secondary SA elements identified for the platoon leader in the analysis across all of the major goals and subgoals in the MOUT mission. Level 3 (projection) SA items are shown flush with the left edge of the cell, while Level 2 (comprehension) elements are indented once, and Level 1 (perception) items are indented twice.

ENEMY THREAT

- Anticipated enemy actions
- project enemy posture
- enemy vulnerabilities
- resistance expected
- projected impact on mission
- projected dispersion around weapons
- projected impact of LP/OP location
- enemy expectations of my behavior
- projected enemy casualties
- likelihood of attack
- enemy level of resistance
- enemy combat power
- projected enemy breach points
- likely enemy avenues of approach
  - enemy maneuverability
  - enemy strengths
  - enemy weaknesses
  - enemy disposition
  - enemy intent
  - enemy objective
  - enemy composition
  - enemy actions
  - enemy strengths/weaknesses
  - probability of enemy contact
  - areas of cover & concealment
  - exposure areas
  - enemy LP/OP locations
  - enemy psychology
  - enemy patterns of movement
  - enemy field of observation
  - enemy field of fire
    - location
    - dispersion
    - numbers
    - weapons
    - ammo/supplies
    - objective
    - unit type
    - equipment
    - experience level
    - morale/commitment
    - vehicle
    - capabilities/skills/training
    - recent actions
    - enemy doctrine
    - past behavior/actions
    - religious/political beliefs
    - locations of ammo/supplies
    - movement of weapons
    - security/patrol formations & schedule
    - enemy center of gravity
    - building vantage points

CIVILIAN SITUATION

- projected civilian behavior
- projected civilian casualties
- projected civilian response
- level of threat
- potential for goodwill
- potential for escalation
  - level of organization
  - mood of crowd
  - religious/political beliefs
  - morale/commitment
  - intent
  - proximity to sensitive sites (church, school, political center, etc)
    - location
    - number
    - agitators present
    - threatening actions
    - weapons
    - training/skills

Rules of Engagement

FRIENDLY SITUATION

- Anticipated friendly actions
- Troop psychology
- Projected troop fatigue
- Soldier mental fatigue
- Projected performance on task
- Potential for fratricide
- Anticipated relative locations of other units
- Own vulnerabilities
- projected casualties
- strategic significance of weapons
- projected impact of action on mission
- projected effect of action
- projected benefit/cost of action
- projected ability to avoid fires
- likelihood of deception success
- projected effects of moving casualties
- ability to detect enemy presence
- ability to avoid enemy detection
- likelihood of enemy contact
  - dispersion required
  - forces required
  - resources required
  - force ratio
  - Commander's Intent
  - unit objective
  - planned friendly actions
  - combat power
  - availability of fires
  - priority of fires
  - combat multipliers available
  - timing of support
  - protection provided
  - friendly composition
  - unit type
  - experience level
  - morale/commitment
  - character of soldiers
  - individual soldier discipline
  - capabilities/skills/training
  - fatigue/soldier load
  - troop disposition
  - distance traveled
  - time in lead/on task
  - resistance encountered
  - troop doctrine
  - past behavior/actions
  - religious/political beliefs
  - friendly field of observation
  - friendly field of fire
  - enemy LP/OP locations
  - supply level
  - re-supply access
  - weapons characteristics
  - Specifics of pre-planned fires
  - Confidence in intelligence information
  - communication plan
  - reliability of comm channel
  - information to communicate
  - areas of poor communication
  - handling of casualties
  - medical facilities/personnel
  - evacuation plan
    - number of casualties
    - severity of casualties
    - commo call signs and frequencies
    - equipment
    - technologies available (NVG, laser, etc)
    - vehicles
    - skills
    - training
    - experience
    - reliability
    - fatigue
    - location
    - dispersion
    - numbers
    - weapons
    - ammo/supplies
    - Range to other troops
    - direction to other troop
    - timing of fires
    - fires calling procedure
    - location of fires
    - troop movement

TERRAIN

- Projected impact of terrain
- Effects of terrain on communications
- Estimated time required for movement
- Projected safety of routes
- Projected physical requirements of route
- Projected mental requirements of route
  - cover & concealment
  - area of operations
  - type of terrain
  - routes of ingress & egress
  - fortifications
  - day/night
  - features
  - high ground
  - construction type
  - conditions
  - building accessibility
  - building usage
    - mechanical entry points
    - explosive entry points
    - rubble
    - mud
    - booby traps
    - areas of damage
    - severity of damage
    - light level available
    - building vantage points
    - windows
    - doorways
    - rooftops
    - vegetation
    - obstacles
    - buildings
    - size/type of room
    - activities in adjacent rooms
    - usage
    - mass construction
    - framed construction
    - entry points
    - vantage points

WEATHER CONDITIONS

- projected effects of weather
  - temperature
  - precipitation
  - wind
    - direction
    - speed
  - light levels
  - visibility
  - ambient noise

TIME CONSIDERATIONS

- Projected time to objective
- Projected difficulty of task
- Projected time to cover & concealment
  - Time constraints
    - time available
    - time required for task/movement

DANGER AREAS

- Projected areas of enemy attack
- Projected areas of enemy detection
  - roads
  - streams
  - open areas
  - railroad tracks
  - corridors
  - stairwells
  - windows
  - doorways
  - funnel areas

Figure 4. SA requirements for Infantry platoon leaders in a MOUT mission.

Phase 2: Situation Awareness Measures Development

This project endeavored to develop both objective and subjective measures of SA to investigate SA for the Infantry platoon leader. Based on the results of the SA requirements analysis, three instruments were developed to measure SA during Infantry platoon leader operations: SAGAT, the Situation Awareness Behaviorally Anchored Rating Scale (SABARS), and the Post-Trial Participant Subjective SA Questionnaire (PSAQ).

Situation Awareness Global Assessment Technique (SAGAT)

The Infantry platoon leader version of SAGAT utilizes a customizable PC-based computer program which presents officers with the same 21 standard queries which are designed to assess all three levels of SA (perception, comprehension, and projection). The queries are presented at discrete points in time during simulated missions. Queries address major SA elements such as location of strongest and weakest enemies and friendlies, number of casualties suffered by the officer's platoon, and expected enemy and civilian actions over the next five minutes.

SAGAT questions were developed by examination of the SA requirements list. Queries were selected based on several criteria:

1. The query must be answerable at any time during the mission,
2. It must have a right or wrong answer,
3. Participants must be able to easily respond to the question (Yes-No, Multiple Choice type queries),
4. Queries must address SA elements, not strategies and decisions which build from SA,
5. Questions must cover all three levels of SA, perception, comprehension and projection.

The SAGAT queries were selected to cover the broadest range of SA requirements possible, across the multiple goal areas that were assessable in the simulation environment. An objective was to create the minimum number of queries that would cover the full range of information requirements. The queries were developed to assess SA at a reportable level that could be scored as correct or incorrect based on simulator or SME input. The queries were reviewed by the SMEs for understandability and appropriateness, and revisions were made accordingly.

This process resulted in 21 questions. Table 1 contains a complete listing of SAGAT queries, along with the available responses. (Eight of the items were not administered in the investigative portion of the study—Phase 3—due to limitations of the simulation or missions. Those items are marked with an asterisk in Table 1.) The SAGAT method permits flexible administration by allowing the test administrator to determine which questions to block, which questions to always show (in random order), and which questions to show in random order *after* those questions that are always presented. Each query was presented graphically on the monitor of a computer. The actual screen image for each query is shown in Appendix B, along with the written instructions.

Table 1

SAGAT Queries

	Query	Response Options
1	Indicate the location(s) of each element on the map.	Enemies, Enemy Heavy Weapons, Myself, Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, Other Friendlies, Civilians, Commander
2	Which enemy element is your highest level threat?	E1-20 (enemies), W1-20 (enemy heavy weapons)
3*	Can all the assigned squad tasks be accomplished within the time requirements?	Yes, No
4	Which enemy locations are the weakest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
5	Which enemy locations are the strongest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
6	Which friendly locations are the weakest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
7	Which friendly locations are the strongest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
8*	Will weather be an impact on operations?	Yes, No
9	Which friendly forces are currently exposed to enemy fire/attack?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
10*	Is fatigue impacting on friendly troops?	Yes, No
11*	Which of the following supplies are insufficient for mission completion?	Water, Ammo, Food, Equipment, Troops, None
12	Does the enemy know the location of your platoon?	Yes, No
13*	Which of the following assets are available to support you?	Supporting fire, Smoke, NVG, Reinforcements, Emergency medical care, None
14*	Which troops are in locations that do NOT offer concealment?	Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, None
15*	Which troops are in locations that do NOT offer cover?	Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, None
16	How many casualties have you suffered?	0, 1, 2, 3, 4, 5, 6, 7, ..., 29, 30, >30
17	What do you expect the enemy to do in the next five minutes?	Attack, Nothing, Move positions, Defend, Retreat, Other
18	What do you expect civilians to do in the next five minutes?	Become hostile, Riot/attack, Form a crowd, Disperse, Nothing, Move positions, Get in the way, Other
19	Who has the advantage in the current situation?	Friendly troops, Enemy troops, Friendly and Enemy troops equal
20*	For which friendly element are plans not being executed as per orders?	Squad 1, Squad 2, Squad 3, Weapons Squad, Other Platoons, Supporting units, None
21	Which friendly elements are NOT in communication with you?	Squad 1, Squad 2, Squad 3, Weapons Squad, Other Platoons, Supporting units, None

* Not used in the soldier-in-the-loop investigation, Phase 3 of this study.

Figure 5 shows the first query always presented to the participant and the foundation for all subsequent queries that showed cartographic data. For this first item, participants identified the locations of friendly, enemy and civilian elements on a map of the virtual environment. Small color-coded icons appeared in a panel on the right side of the screen and participants used a standard drag-and-drop technique to place items on the map or to move them from one location to another once they have been "dropped" onto the map. Some elements permitted the creation of multiple reports, such as Enemies, Enemy Heavy Weapons, Adjacent/Other Friendly Troops, Detached Troops and Civilians. Icons for other elements were removed once they were placed

onto the map. The participant was only allowed to locate one Myself, Squad 1, Squad 2, Squad 3, Weapons Squad, and Commander. When the participant was satisfied that he had placed all elements onto the map in their correct location, he selected "Done" in the bottom right hand corner, and the next query was presented. All subsequent queries were presented in random order, to prevent participants from anticipating the queries and thus "preparing" for the SA assessment by paying special attention to those elements covered in the SAGAT queries. (Note: If this type of selective attention process had occurred, officers would be expected to perform better on later halts than on earlier halts. The data analysis showed no such trend.)

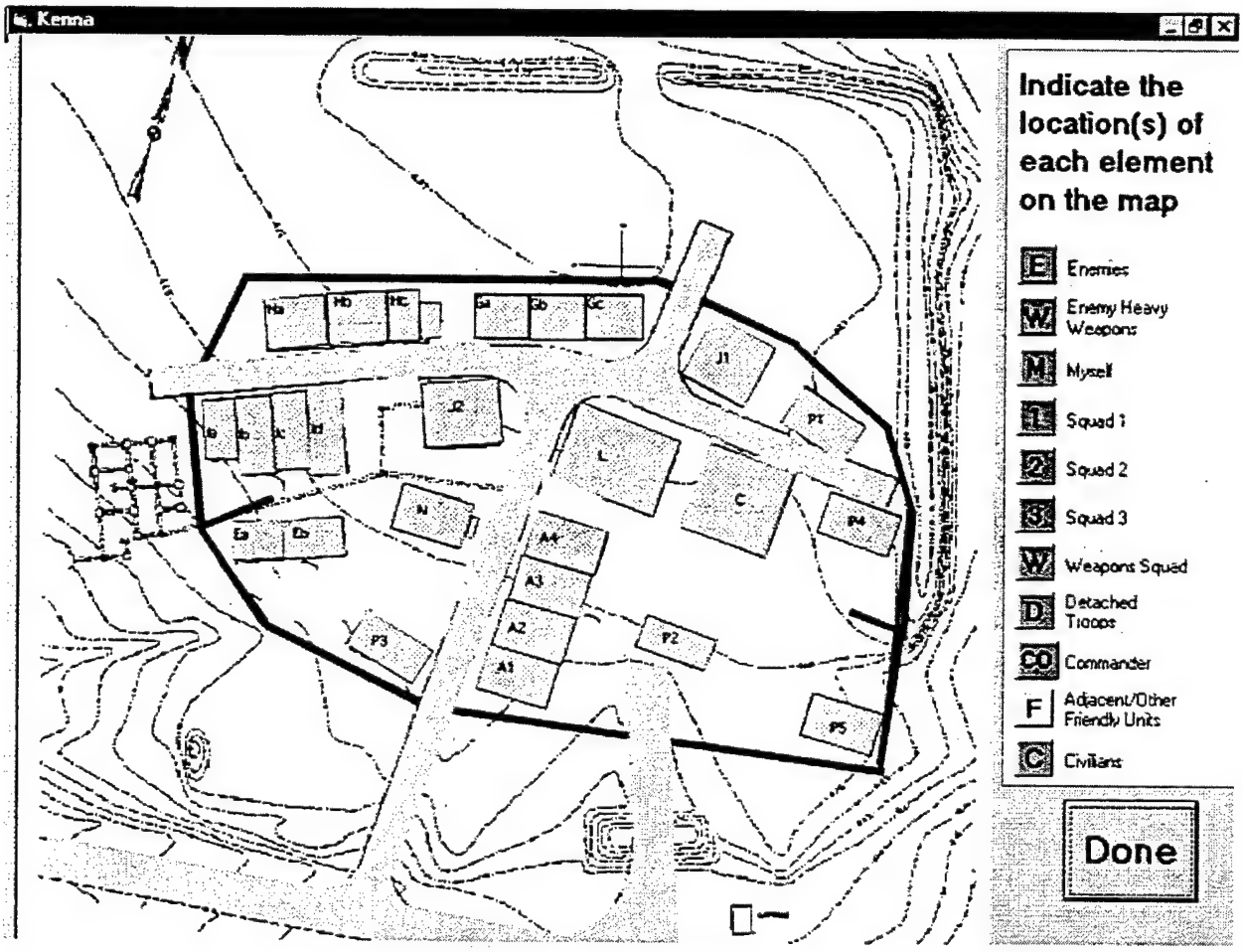

Figure 5. SAGAT query 1.

Situation Awareness Behaviorally Anchored Rating Scale (SABARS)

The SABARS measures consisted of 28 questions selected from the question pool developed during Phase 1 and judged by an SME familiar with all aspects of the project to have relevance for the SSE simulation. The final questionnaire was reviewed by all six SMEs for understandability and revised as needed. The SABARS items elicited ratings from an independent Observer/Controller (O/C) on how well the platoon leader exhibited behaviors consistent with acquiring and disseminating SA information during the exercise. Since SA

actually refers to an individual's internal representations of elements in the environment (perceptions, comprehension, and projections), it is important to note that the SABARs measure does not rate actual SA, but rather outward actions that indicate a greater likelihood of good internal representations. While behaviors can be an important indicator of mental processes, they can also be misleading.

The O/C's subjective rating of the participant's SA-related behaviors was assessed using items such as *"Solicits information from squad leaders," "Communicates key information to commander," "Asks for pertinent intelligence information," "Identifies critical mission tasks to squad leaders,"* and *"Assesses key finds and unusual events."* The quality of the behaviors were rated on a five-point scale ranging from 1 = "Very Poor" to 5 = "Very Good," with intermediate ratings of "Poor," "Borderline," and "Good." An additional response of "Not Applicable" was added to the scale for behaviors that were either not demonstrated or could not be assessed from the scenario. The SABARS instrument is shown in Appendix C.

Post-Trial Participant Subjective Situation Awareness Questionnaire (PSAQ)

The PSAQ instrument (presented in Appendix D) consisted of three items designed to elicit the participant's subjective ratings for:

- workload—how hard the officer worked during the scenario,
- performance—how well the officer performed during the scenario, and
- self-perceived SA—how aware the officer was of the evolving situation.

These items were rated on a five-point scale. For workload, a rating of 1 meant that the officer was not working hard, while 5 meant he was working extremely hard. For performance, a low rating reflected poor performance, while a high rating reflected extremely good performance. A rating of 1 on SA indicated that the officer was not aware of the evolving situation, while a rating of 5 indicated the officer was completely aware of the evolving situation.

Phase 3: Soldier-in-the-Loop Investigation

Conducted in an immersive virtual simulation environment, the purpose of the third phase of the study was four-fold: (a) examine the suitability of the SA instruments developed during Phase 2; (b) explore how experienced officers might differ from inexperienced officers in terms of SA; (c) explore the effects of different scenarios and measurement halts on SA; and (d) examine the interrelationships among the various SA measures used.

Method

Participants

Fourteen officers (13 Infantry and one Armor) participated in the investigation. The average age of the seven lieutenants was 23.7 years. For the captains, the average age was 27.9 years. Time in service ranged from 11 to 83 months for lieutenants and 49 to 133 months for captains. All captains had served as platoon leaders while none of the lieutenants had served in that position. All officers were Airborne qualified and four from each group had completed

Ranger school. Six lieutenants and three captains had engaged in training exercises at the McKenna MOUT site at Fort Benning, but only one officer had ever been in an SSE simulator like that used in this experiment (Pleban, Eakin, Salter, & Matthews, 2001).

Materials

Biographical Information Questionnaire. The Biographical Information Questionnaire (presented in Appendix E) was a paper-and-pencil instrument designed to elicit general biographical information from the participant such as age, prior military experience and training.

SAGAT. A laptop computer was used to administer SAGAT during three halts in each of two scenarios: Assault and Defend. Queries were presented either until the participant completed the full battery, or until 4 minutes had elapsed, whichever came first, at which time the platoon leader returned to the combat simulation. Of the 21 queries in the SAGAT battery, 13 were deemed appropriate for the scenarios used and the capabilities of the SSE (see Table 1, where the omitted items are denoted by asterisks).

SABARS. Immediately following completion of each of the four scenarios, the O/C, a retired Infantry officer, completed a SABARS rating form based on the participant's behaviors. It should be noted here that eight items were removed from the analysis due to a large number of "Not Applicable" ratings. These eight items are marked with an asterisk in the SABARS rating form found in Appendix C.

PSAQ. The PSAQ was administered at the conclusion of each of the four scenarios, and participants rated each item along a five-point scale. Response categories varied for each question (see Appendix D). Officer comments were solicited at the end of each item.

Small Unit Leader Decision-Making Scenarios

Scenarios were set in a small European-style town, a virtual representation of the McKenna MOUT training site at Fort Benning, Georgia. Infantry SMEs developed six possible scenarios; four were selected for the variety and training value provided. The four scenarios were Assault, Defend, SASO and Secure Village/Downed Helicopter. In each scenario, between four and seven decision points occurred, where specific decision-making actions were expected, e.g., notify commander of movement, determine status of injured soldiers, warn troops against firing on civilians. Each platoon leader participant completed all four scenarios, but only the Defend and Assault scenarios were used for SAGAT measurements. See Appendices F and G for flow charts delineating the action sequence and decision points for each SAGAT scenario.

Simulated scenarios focused on the interactions between the participant, who filled the role of platoon leader, and his Commanding Officer (CO), three squad leaders, and platoon sergeant. Scenario developers presented cognitively challenging simulations through the use of severe time constraints, realistic and complex situations, incomplete or uncertain information, and multiple decisions. A wide variety of events were utilized, e.g., sniper fire, injured soldiers/civilians, NBC (Nuclear, Biological, and Chemical) threat, death of CO. Scenario

instructions required minimal movement from the participants to maintain the focus on the decision-making aspects of the scenarios.

Simulation Environment

Three full-immersion SSE simulators from the Dismounted Battlespace Battle Lab's Land Warrior Test Bed at Fort Benning, Georgia, were employed; one for the platoon leader and two for role-playing squad leaders. The CO used a joystick-controlled desktop version of the SSE immersible system. Each SSE simulator consisted of an enclosure with black, sound-dampening fabric on three sides and a 9-ft by 8-ft projection screen as the fourth wall. The enclosures reduced extraneous light and minimized distractions from outside sources. One side of the rear panel fabric in the participant's enclosure was tied back to permit observation by those recording the results of the research. Using a communication system similar to those used in the field, participants were able to communicate with squad leaders, the CO, and the platoon sergeant. For a more complete description of the SSE simulation, see Pleban et al. (2001).

Procedure

Each individual platoon leader participated in the simulation on one day. The order of participants (experienced vs inexperienced platoon leaders) was alternated across days, to guard against any confounding effects of improvements in training processes or trainers over successive days. (For a more complete description of the procedures used, see Pleban et al. (2001).)

Participant training. A different participant served as platoon leader each day. The participant arrived early in the morning for an initial briefing on the research objectives. After completion of the Biographical Information Questionnaire, the SAGAT test administrator presented the participant with written instructions on the SAGAT procedures (Appendix B), then led the participant through a trial SAGAT run on the laptop computer.

Following SAGAT training, the participant entered the simulator for a brief training session, with instruction on some of the key features. In addition, he was shown how various entities were depicted in the virtual environment, i.e., enemies, civilians, and vehicles.

Experimental procedure. At the completion of training, the participant received written personal profiles of the CO, the three squad leaders, and the platoon sergeant. These profiles provided cues to guide the platoon leader in determining which squads to deploy to meet various mission objectives. The role-player CO then met with the platoon leader for a mission briefing, followed by the opportunity for questions and 10-15 minutes to develop a plan before briefing the squad leaders and platoon sergeant on the plan. At this time, the platoon leader and role-players proceeded to their assigned positions, performed system checks, and began the exercise.

Participants encountered either the SASO or Downed Helicopter/Secure Village scenario first, as the pre-test condition, followed by Assault, then Defend, then and the remaining scenario. During each scenario, a researcher recorded data regarding the decisions made by the platoon leader while the O/C supplied limited direction to the participant as needed. If the

participant failed to perform key actions, he was prompted accordingly. At the conclusion of each scenario, the O/C provided feedback to the participant on actions not performed or incorrect information relayed. Next, the participant completed the PSAQ while the O/C completed the SABARS instrument. Each scenario ended with an After Action Review (AAR) guided by the CO.

SAGAT. Administration of SAGAT occurred during the Assault (2^{nd}) and Defend (3^{rd}) scenarios. When the action was halted at three predetermined halt points in each scenario, the SAGAT administrator wheeled a cart holding a laptop computer over to the participant. Each SAGAT session lasted a maximum of 4 minutes, less if the participant completed the questions before the allotted time expired. The timer began as soon as the participant clicked the "Start" button (see Appendix B). For identification purposes, the participant's name along with the scenario and halt number were displayed at the top of the start screen. Query 1, asking the participant to locate all elements on a map, was always presented first. After the participant completed locating elements on the map, subsequent queries were presented in random order. While the participant completed the SAGAT queries, the role-player CO completed a paper and pencil version of the SAGAT queries which was then used to score the participant's responses. At the conclusion of each SAGAT halt, the laptop was removed and the simulation resumed exactly where it had been halted.

Responses for each question were captured in a data file by the SAGAT program. Separate files were created for each participant and each SAGAT Scenario. A technical problem resulted in loss of data for the first participant in the Assault Scenario. Each line of data in the file contained the participant number, scenario, trial number, halt number, query number, and the participant's response.

The SAGAT program stored X and Y coordinates for each element in Query 1 along with a unique label identifying the item. For example, the fifth enemy location identified would be labeled E5. Another program read these coordinates from the data file and positioned the elements on a map. This map was used to score both location data and subsequent questions about the relative strength and weakness of friendly and enemy troops. For an example of a completed map, see Figure 6.

To score location data, the participant-generated map was compared with (a) a screen shot from the simulation's Plan View Display showing the actual locations of the computer-generated squads engaged in the exercise, (b) the key provided by the CO, and (c) the briefing materials given to participant before each scenario. Analysis was limited by the fact that enemies and adjacent friendly platoons were not actually depicted by the computer simulation, so they had no physical location in the virtual world even though the results of their actions were seen and heard by the participant. As a result, some latitude was allowed in the identification of correct locations for these elements of the simulation, giving the benefit of the doubt to the participant. Missing data were omitted from the analyses.

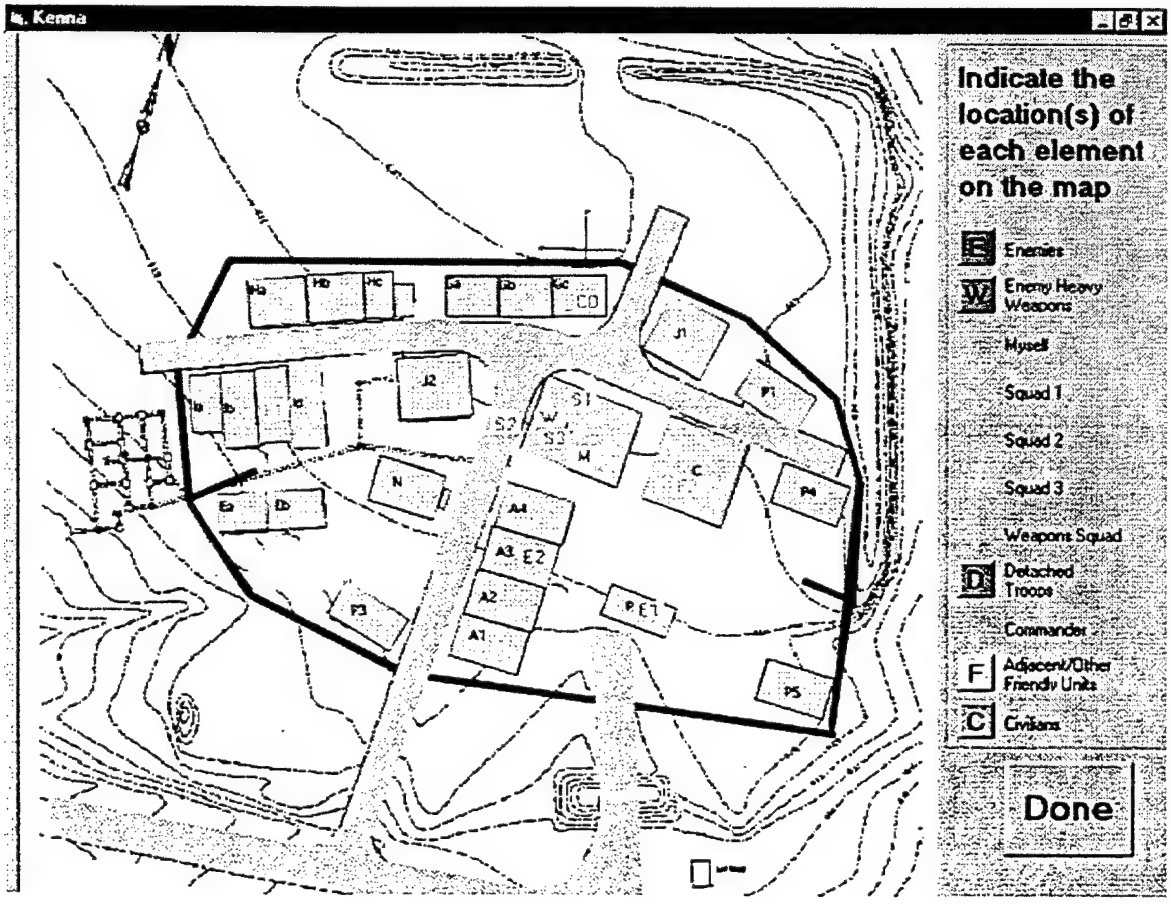

Figure 6. SAGAT query 1 showing elements located on the map by a participant.

Results

The various SA measures were examined to determine the impact of Experience Level and Scenario Type on platoon leader SA during the exercises. The results for each SA measure are presented separately. Subsequently, the relationship among the SA measures is discussed.

Objective Ratings of Situation Awareness

The platoon leader's responses to each SAGAT query were compared to the actual state of the environment at the time of the halt as recorded by the simulation computer and the trained SME/observer. This process provided an accuracy score for each query. The first query provided during each halt asked participants to report on the location of their own platoon elements, adjacent friendly elements, and enemy elements. Due to the highly scripted nature of the scenarios and the timing of the halts, adjacent friendly units and enemy elements occupied consistent locations for a given scenario and halt for all study participants. Thus, if a sniper fired shots from building P-2 during the Assault scenario for the first participant, he did the same for every other participant. This facilitated identification of the number of items that participants should have located on the map for a given halt. The percentages of elements that participants correctly located in each of these three categories (own, adjacent, and enemy elements), along

with the total percentage of correctly identified elements, were calculated. Accuracy for the remaining queries was calculated, based on the data collected from the simulator computer and the SME/observer.

The accuracy scores for each SAGAT query type were analyzed via Analysis of Variance (ANOVA) to determine whether they displayed sensitivity to differences in Experience, Scenario, and Halt Number, and the interactions among these variables. (An arc tan transformation was applied to the SAGAT scores prior to analysis in order to meet the assumptions of homogeneity of variance.) An overall SAGAT score was computed, however, past studies have shown that SA accuracy on individual queries is highly independent, leading a combined SAGAT measure to be insensitive (i.e., it tends to mask trade-offs in SA between different aspects of the situation). The results of this study were no different. As expected, the overall SAGAT score showed no significant relationship with Experience, Scenario or Halt Number. Therefore, each query was analyzed individually to determine sensitivity to experience, scenario and halt effects, and the interactions among them. Results of the ANOVAs for each SAGAT query type are shown in Appendix H (Tables H-1 through H-42), along with the means for each condition combination. Only the results of statistically significant differences ($\alpha = .05$) will be discussed.

Experience. Two of the four location items showed significant differences between experience levels. The more experienced participants were significantly better at locating both enemy troops ($p = .03$) and elements of their own platoon ($p = .03$) on the map. Three additional SAGAT queries exhibited significant differences for experience level, with more experienced officers better at identifying both the location of the strongest enemy ($p < .01$) and the location of the element posing the highest threat to their platoon ($p = .01$) than less experienced officers. Conversely, less experienced participants were better at identifying locations of the strongest friendly elements than more experienced officers ($p = .01$). Figure 7 shows these significant experience level differences. No other SAGAT queries produced significant differences between experience levels.

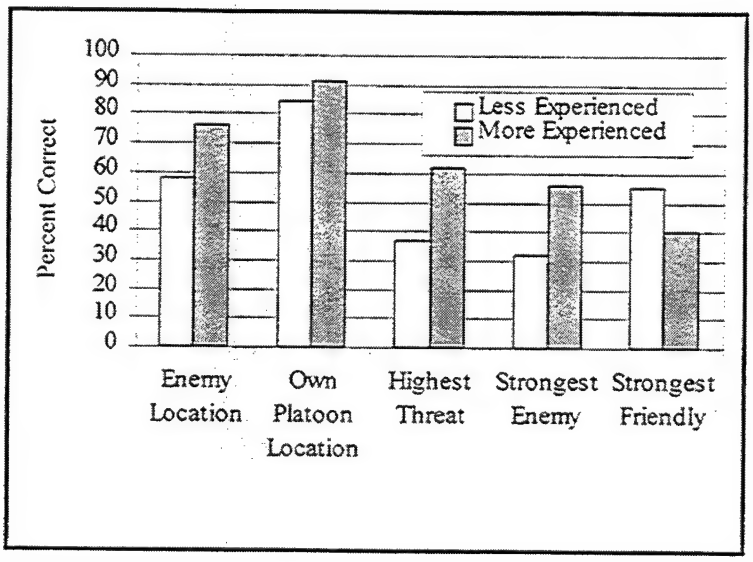

Figure 7. SAGAT mean scores by experience level.

Scenario. Several queries showed a significant effect for Scenario with participants scoring higher in the Assault scenario in identifying the strongest friendly element ($p < .001$), determining whether enemies knew the participant's location ($p = .02$), and the degree to which they predicted future enemy actions ($p < .001$). In addition, participants had higher SA in the Assault scenario regarding the locations of adjacent friendly units ($p < .01$) and total elements correctly located overall ($p < .001$). Higher SA scores were found in the Defend scenario for identifying the locations of the weakest enemy elements ($p < .001$) and exposed friendly elements ($p < .001$), and knowing the number of casualties suffered ($p < .001$). In the Defend scenario, however, no casualties were suffered at least until the third SAGAT halt, while in the Assault scenario, the officer's platoon suffered casualties even before the first SAGAT halt occurred. Similarly, there was no close or clearly defined threat until the third halt of the Defend scenario, and therefore no opportunity for friendly troops to be exposed to enemy fire. Thus, the number of casualties was zero and enemies did nothing for most of the Defend scenario, making those much easier questions to answer in this case. The observed differences may also reflect the fact that the Assault scenario always preceded the Defend scenario. Figure 8 depicts the significant differences between scenarios.

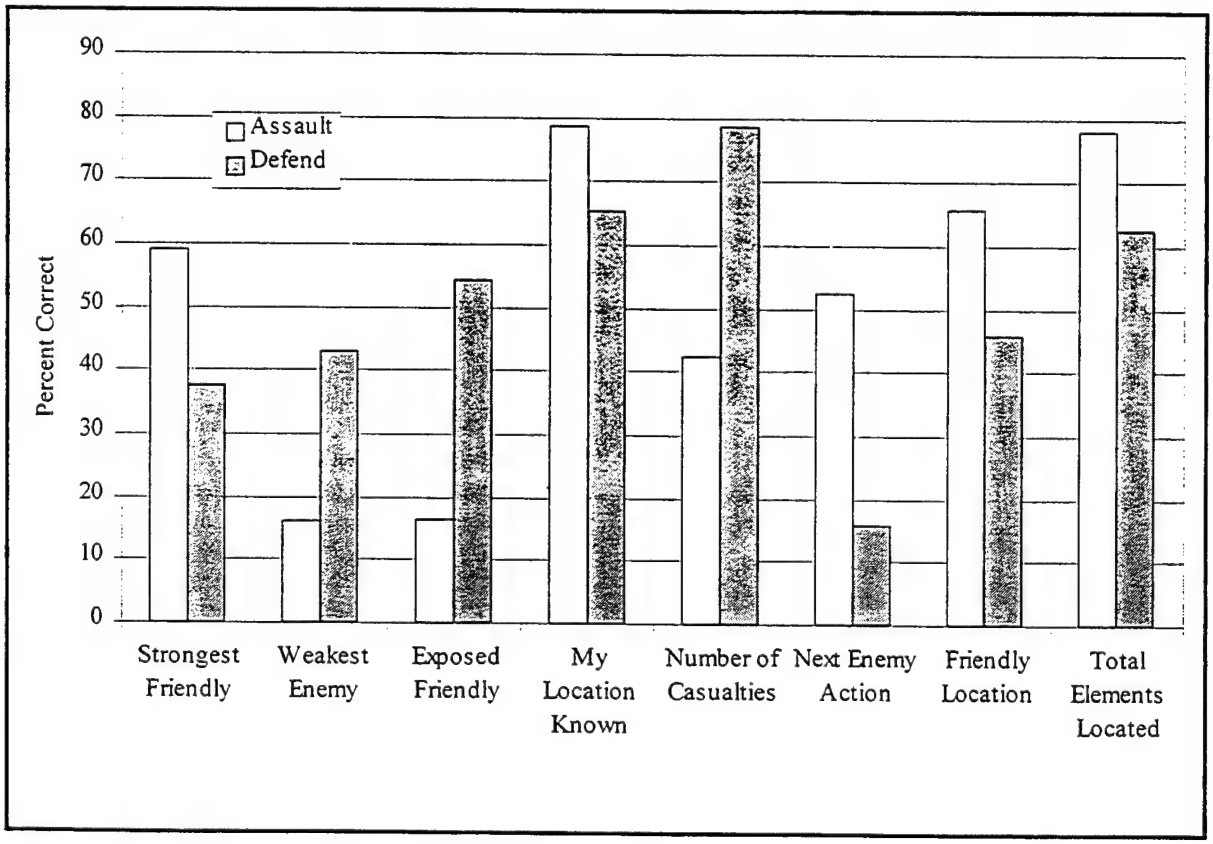

Figure 8. SAGAT mean scores by scenario.

Halt number. Three SAGAT queries showed a significant effect for SAGAT Halt Number: expected enemy actions ($p < .001$), expected civilian actions ($p < .01$), and own location known by enemy (see Figure 9). For these three queries, performance declined after the

first halt, possibly indicating that SA on these factors declined as the scenario progressed and pre-mission briefing information became more dated. It may also reflect the complexity and uncertainty that are characteristic of these missions. These results do discount the possibility that participants may have been preparing for the SAGAT queries, as they did not improve with practice, in agreement with previous research on this technique.

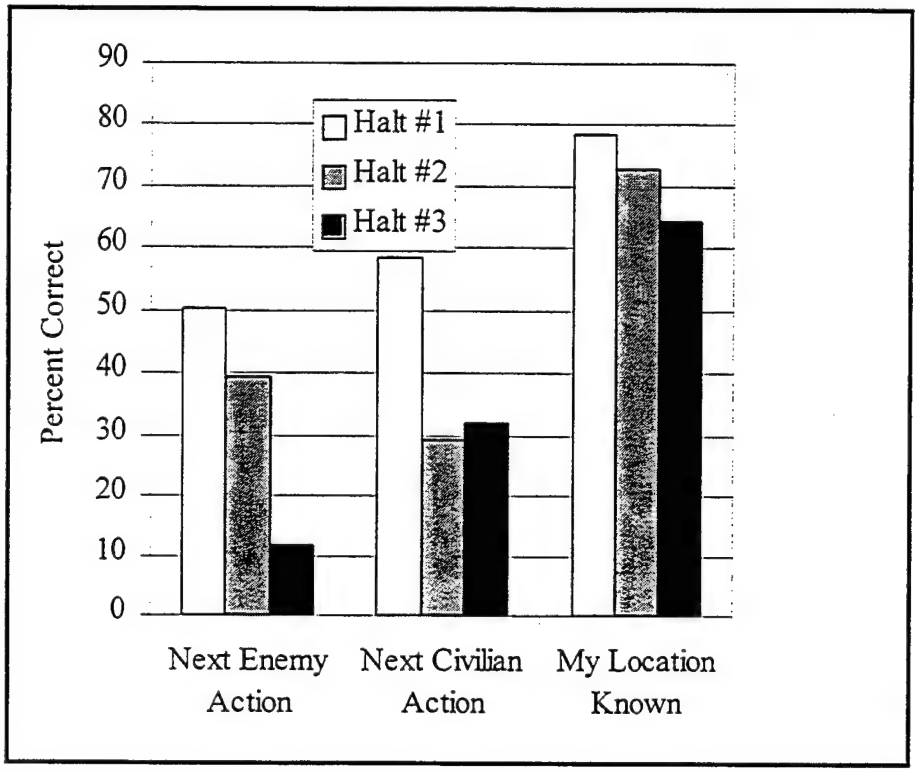

Figure 9. SAGAT mean scores by halt number.

Interaction Effects. Finally, four significant interactions were identified: a scenario by halt interaction for identification of strongest enemy ($p = .01$), own location known by enemy ($p = .04$), expected enemy actions ($p < .001$), and expected civilian actions ($p = .03$) (see Figure 10). Knowledge of the strongest enemy location improved over time in the Defend Scenario, while it declined over time in the Assault Scenario. For expected enemy actions, SA started out much higher in the Assault scenario than in the Defend scenario, possibly due to elapsed time from the pre-mission briefing. Knowledge of civilian actions started out higher in the Defend Scenario, but decreased more than in the Assault Scenario. Knowledge of whether the enemy was aware of the platoon location decreased at the end of the Defend Scenario, but not the Assault Scenario. These findings could also be an artifact of scenario structure, and must be viewed with caution.

There was one significant Experience Level by Scenario Interaction regarding knowledge of communications with friendly elements ($p = .02$) with experienced platoon leaders being more aware of this in the defend scenario than the assault scenario and novice platoon leaders showing the opposite pattern (see Figure 11).

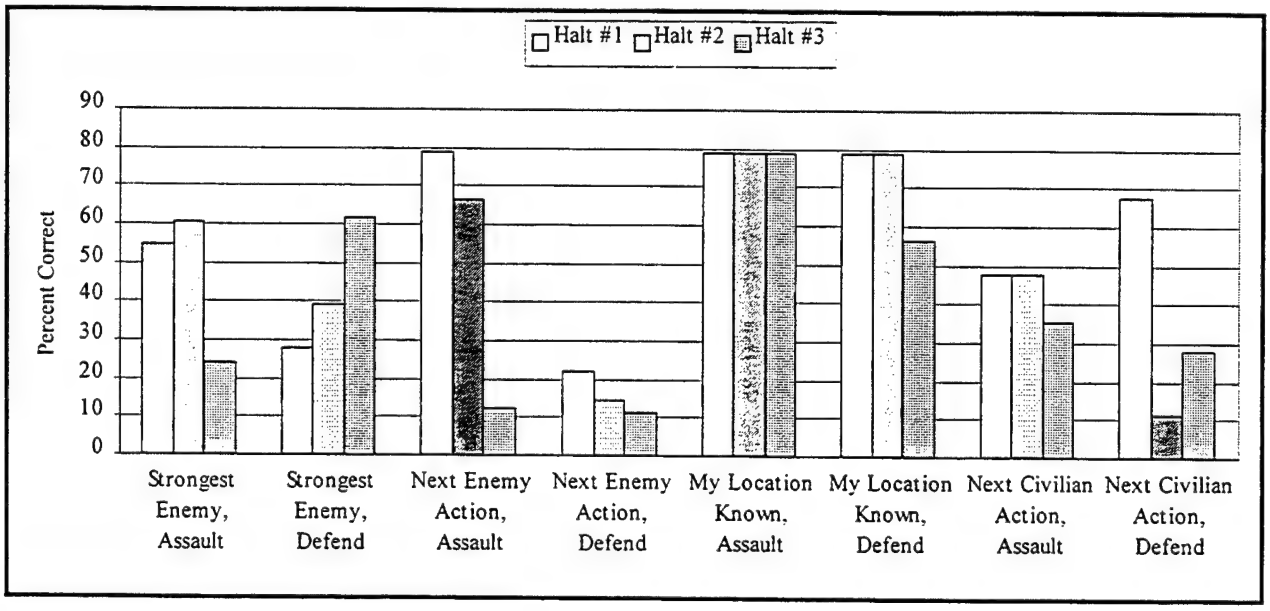

Figure 10. SAGAT mean scores–scenario by halt interactions.

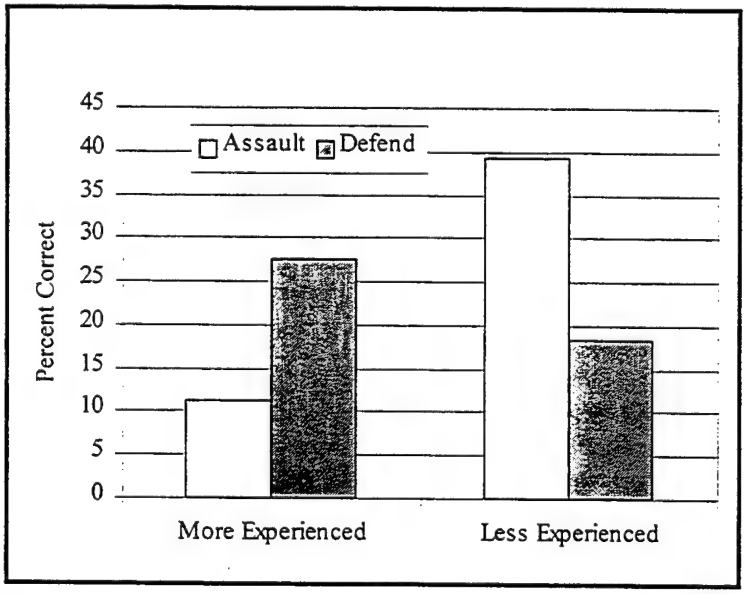

Figure 11. Knowledge of communications with friendly elements by experience level and scenario.

Subjective Observer Ratings of Situation Awareness on SABARS

Twenty SABARS items were completed by the O/C for each scenario. Scores for these items were subjected to a factor analysis. The analysis resulted in combining the 20 SABARS items into four factors (see Table H-33), which account for approximately 67% of the variance in

the items (see Table H-34). The factors are shown in Table 2. Two additional factors did not load heavily on any SABARS items and were of questionable value (contributing only an additional 12%). In view of the small sample size, those two factors were dropped from the analysis. It should be noted that many of the items were highly intercorrelated (Table H-35).

Table 2

SABARS Factors

Factor 1: Gathering Information and Following Procedures	**Factor 2: Focusing Externally versus Internally**	**Factor 3: Proactively Seeking Key Information**	**Factor 4: Focusing on the Big Picture**
Uses assets to effectively assess environment	*Identifies critical mission tasks to squad leaders* (-)	*Employs squads tactically to gather needed information*	*Communicates key information to squad leaders*
Utilizes a standard reporting procedure	*Solicits information from squad leaders(-)*	*Discerns key information from reports received*	*Communicates to squads overall situation and Commander's intent*
Identifies OCOKA elements	*Communicates key information to* commander	*Ensures avenues of approach are covered*	*Solicits information from commanders*
Sets appropriate levels of alert	*Gathers follow up information when needed*	*Locates self at vantage point to observe main effort*	*Monitors company net*
Assesses information received	*Asks for pertinent intelligence information*	*Assesses key finds and unusual events*	*Asks for pertinent intelligence information*
Gathers follow up information when needed	*Assesses key finds and unusual events*	*Overall situation awareness rating*	*Communicates key information to commander*
Monitors company net	*Discerns key information from reports received*	*Solicits information from commanders*	
Overall situation awareness rating		*Assesses information received*	
Assesses key finds and unusual events		*Identifies OCOKA elements*	

Note: Loadings are positive unless otherwise indicated by a negative sign.

Factor 1, with all positive factor loadings as seen in Table 2, is labeled Gathering Information/Following Procedures. The highest loadings for Factor 2 were in a negative direction for Identifies critical mission tasks to squad leaders, and Solicits information from squad leaders, leading experimenters to refer to this factor as Focusing Externally versus Internally, where Internally refers to the leader's platoon, and Externally refers to resources outside the platoon. Factor 3 is called Proactively Seeking Key Information because the information is actively sought and the focus is on key information. Factor 4, centered on communicating key information, is called Focusing on the Big Picture. Factor scores were computed based on the weighted combination of all items with a factor loading of higher than 0.30 on each factor.

These four SABARS factors were analyzed by ANOVA (Appendix H, Tables H-36 through 39) for all four scenarios to determine whether the behaviors differed significantly across Experience Level or Scenario, or if there was an Experience Level by Scenario

Interaction. The ANOVAs for the SABARS factor scores showed two significant effects. Factor 1—Gathering Information/Following Procedures—showed significant effect ($p = .05$) for Experience Level, with more experienced officers receiving higher scores, as shown in Figure 12.

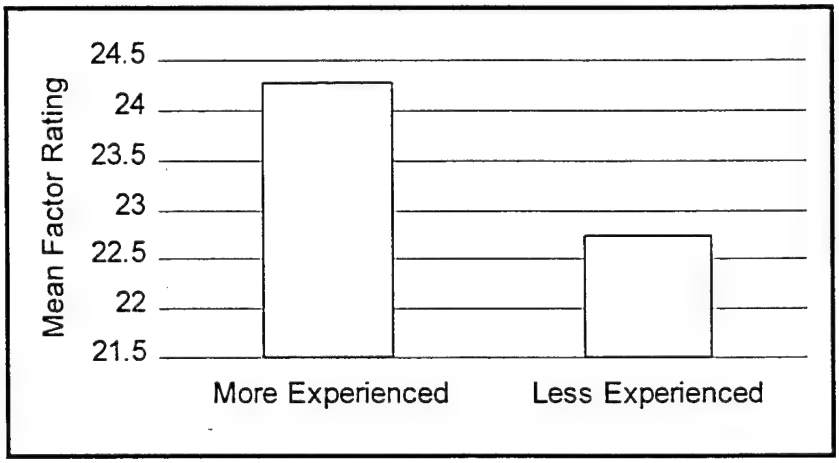

Figure 12. SABARS scores for gathering information/following procedures by experience level.

Factor 4—Focusing on the big picture also showed a significant effect ($p = .01$) for Experience Level, with more experienced officers receiving higher scores, as shown in Figure 13.

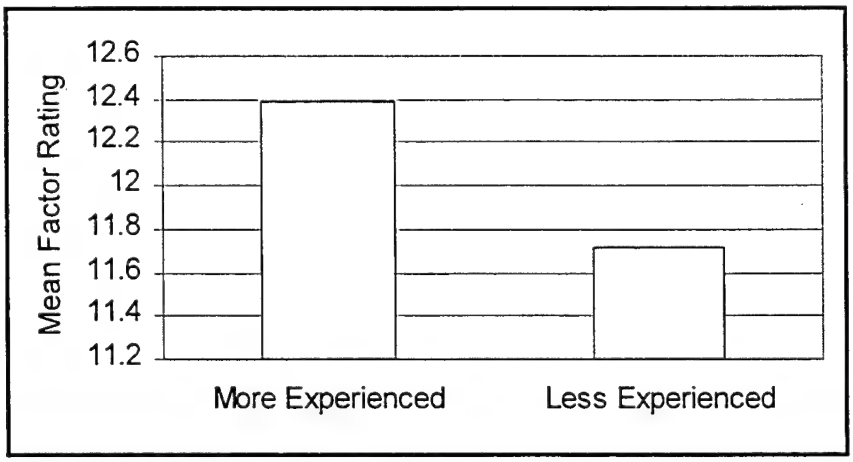

Table 13. SABARS scores for focusing on the big picture by experience level.

Subjective Self-Ratings of Situation Awareness

Participants' PSAQ ratings of Workload, Performance and SA were analyzed via ANOVA (Appendix H, Tables H-40 through 42) for all four scenarios, but no significant effects were found for Experience Level, Scenario or an Experience Level by Scenario Interaction.

Comparison of Situation Awareness Measures

Although SAGAT has been well validated in many studies in a variety of environments, the SABARS measure is a relatively new measure of SA. To determine whether the behaviors as rated on the SABARS questionnaire or the PSAQ self-ratings are predictive of the level of SA measured via SAGAT, step-wise regression analyses were conducted. With each of the SAGAT queries as dependent variables, regressions examined whether any of the SABARS or PSAQ measures predicted SAGAT performance (on the same scenarios for the same participant).

Generally none or only one item showed up in most of the regression models as being predictive of SA as measured by SAGAT. This may reflect low predictiveness of some of the SABARS measures, or that SABARS and SAGAT are tapping into unrelated aspects of SA. It may also reflect the small sample size of the investigation.

As shown in Table 3, SABARS factors and PSAQ measures accounted for a significant portion of the variance in five SAGAT queries. Factor 4, Focusing on the Big Picture, explains 31.1% of the variance in percentage of enemy locations correctly identified, while PSAQ Workload explains 15.1% of the variance in identifying the locations of adjacent friendly units. Factor 3, Seeking Key Information, accounts for 21.6% of the variance in identifying the location of the strongest friendly force. Two items, SABARS Factor 3, Seeking Key Information, and the PSAQ measure of SA explain 41.3% of the variance in the participants' ability to correctly identify the number of casualties suffered. Finally, PSAQ Workload comprises 22.9% of the variance in the degree to which participants were aware of which force had the advantage. Table 3 shows these significant relationships, with their associated F-values, probability values and the squared correlation (R^2) values, corresponding to the portion of variance in the dependent variable (SAGAT query) accounted for by the model (SABARS and PSAQ measures).

One caveat must be added here: some of these SA measures are highly inter-correlated. (See Table H-35, showing the correlation matrix for all SAGAT measures with significant correlations highlighted.) Inter-correlation of variables can have significant implications for the validity of the regression model (for example, only one of two highly correlated variables might be included). Further research is needed to confirm these results.

Table 3

Summary of SAGAT Regression Analysis with SABARS and PSAQ Ratings

SAGAT Query	Model	F-Value	P-Value	R^2
Enemy Locations	4-Big Picture Focus	11.293	0.003	0.311
Adjacent Friendly Locations	Self-Rated Workload	4.442	0.045	0.151
Strongest Friendly	3-Seeks Key Info	6.871	0.015	0.216
# Casualties	3-Seeks Key Info, Self-Rated SA	8.434	0.002	0.413
Advantage	Self-Rated Workload	7.429	0.012	0.229

Discussion

These findings from the soldier-in-the-loop investigation show an interesting effect of experience on platoon leader SA. While more experienced officers demonstrated superior Level 1 SA in identifying the locations of both their own troops and enemy troops—as would be expected, the more important story involves the subsequent cognitive processes—the transformation of the information into higher-level SA. More experienced officers identified the strongest enemy and the highest enemy threat with greater accuracy than officers with less experience, while less experienced officers demonstrated superior performance at identifying the strongest friendly elements. Thus, not only did experienced leaders demonstrate higher levels of SA on certain factors, as might be expected, but SA also proved qualitatively different with level of experience. That is, with increasing levels of experience, platoon leaders shift their focus from concentrating on friendly disposition to focusing more on enemy disposition. In support of this finding, Shattuck, Graham, Merlo and Hah (2000) conducted a card sort procedure in which they found that novices initially requested more information on friendlies than enemies, but experienced officers tended to prefer enemy information to friendly information. This shift in information attended to with the gaining of experience merits careful investigation. Training programs that teach new officers which information is most important, and how to assess and assimilate enemy information into their mental picture, may be warranted as the Army increasingly strives to develop more cost-effective methods for training new officers.

In addition to examining the SA of platoon leaders, this research represents an initial effort to systematically develop a SAGAT battery for Infantry operations. While the present research was not designed to validate the measures, per se, it provides a good indication of their sensitivity and utility for assessing SA in Infantry operations. The SAGAT measures showed good sensitivity to differences in platoon leader experience level and scenario and demonstrated how SA changed significantly over the course of the simulation exercises. Given that SA is a multi-dimensional construct, it is also important that SAGAT showed good diagnosticity in revealing the ways in which SA changed across experience levels and scenarios. Overall, the investigation indicates that further use and development of the SAGAT measure in Infantry exercises would be warranted.

The SABARS instrument represents an initial attempt to develop a subjective scale of situation assessment behaviors that might be useful for evaluating SA in Infantry operations. Ratings indicated that more experienced officers exhibited more behaviors related to Gathering Information and Following Procedures (Factor 1) than less experienced officers, as might be expected. Because the rater completing the SABARS questions knew which officers were experienced and which were not, however, it is possible that this merely reflected a halo effect.

Two SABARS factors, Proactively Seeking Key Information and Focusing on the Big Picture, were significantly predictive of the level of SA exhibited by the officers on several SAGAT queries. Behaviors associated with Focusing on the Big Picture accounted for almost one-third of the variance in the platoon leader's knowledge of enemy locations. Results indicating that more experienced officers focus greater attention on enemy disposition suggest that training new officers in the behaviors associated with Focusing on the Big Picture may be effective in increasing SA among less experienced officers. Proactively Seeking Key Information demonstrated significant predictive value for the officers' knowledge of the strongest friendly location and the number of own casualties.

It should be noted that this was an initial attempt to look at the utility of a measure such as SABARS. Since it was collected with only one rater, no analysis can be made of its reliability. In addition, only a small sample size was available in this research. Its results must therefore be caveated accordingly. More research is needed to assess both the reliability and validity of this measure.

Since this research was based on a small sample, it is difficult to say whether these findings will hold up to further investigation or whether additional relationships between the SABARS factors and the level of SA possessed by platoon leaders might exist. Therefore, no serious changes to SABARS are recommended at this time. Rather, these findings can only be taken to indicate a tentative level of utility for such a measure. Further research is needed to examine the SABARS scales with a larger test population and a wider range of scenarios and testing conditions. Also, it should be noted that the relationships found are modest, though significant. Research is needed to further determine significant sources of SA differences in addition to the behaviors incorporated on this scale. The PSAQ scales were not sensitive to the experience levels or scenarios used in this research.

While evidence for the sensitivity of global measures of self-rated SA and workload such as those used here has been mixed, PSAQ ratings did show some sensitivity in the present research. Self-rated SA was significantly related to the officers' knowledge of the number of casualties. Self-rated workload was significantly related to the officer's knowledge of the location of adjacent friendlies and which side had the advantage. Workload has been found to be significantly related to low SA in other domains, and under certain conditions can certainly be seen to be a problem for SA in Infantry operations.

Finally, as a part of this research, a significant effort was made to delineate the SA requirements of platoon leaders. This analysis should be seen as preliminary and should be further developed and validated with Infantry officers who are experienced in MOUT operations. In addition, similar analyses are needed for other Infantry missions and echelons. In addition to

providing the basis for the development of the SA measures used in this research, these analyses of goals, decisions and SA requirements are highly valuable in developing new technologies and training methods for improving SA in Infantry operations.

Pleban et al. (2001) present additional results of the soldier-in-the-loop investigation, to include decision-making performance and relationships between SA and decision-making.

Conclusions

In conclusion, an exploratory research effort to examine the degree to which SA could be measured in simulated MOUT missions was conducted. A battery of objective and subjective measures suitable for Infantry operations was developed, based on a detailed analysis of the platoon leader's situation awareness requirements, and tested The results of this analysis demonstrate that these measures, particularly SAGAT, show good promise for measuring SA in future studies of Infantry operations. Other measures merit more testing and evolution.

It is important to remember that these data were obtained from scenarios run in a virtual environment designed for individual combatants. The results of this research effort provide support for the utility of such scenarios in both research and training exercises. Future research would benefit, however, from studies conducted in diverse locations, including actual field studies during training exercises at a training facility such as the McKenna MOUT site at Fort Benning. Although the difficulties of conducting research in such an environment are great, they are not insurmountable, and would provide important information regarding elements of the SA construct that are impossible to investigate at this time in the virtual environment.

Future studies also should continue to validate these measures of SA, specifically by looking for links between measures of performance or decision-making and measures of SA. Because SA is a multidimensional construct, it is reasonable to assume that multidimensional performance and decision-making measures will provide the most utility for comparison with measures of SA. Just as an overall SAGAT accuracy score fails to show effects for experience, comparison of specific SA measures to overall performance measures are likely to obscure relationships that may exist between SA and specific decisions or outcomes. Further work is needed to develop SA requirements for other Infantry positions, following the methods used here, and to develop SA measures to allow for research on SA at different echelons. Further research to refine and validate these SA measures is also needed.

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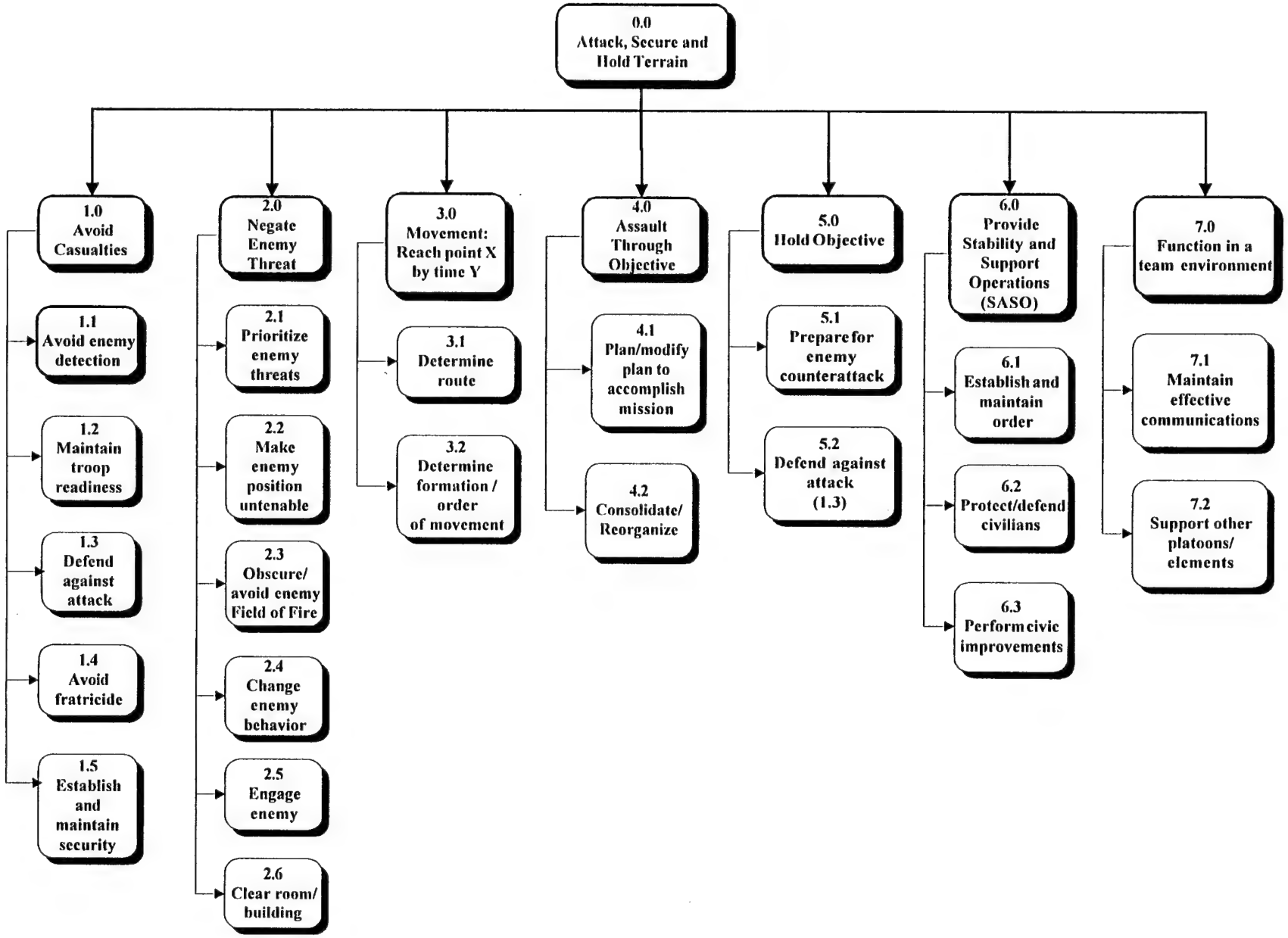
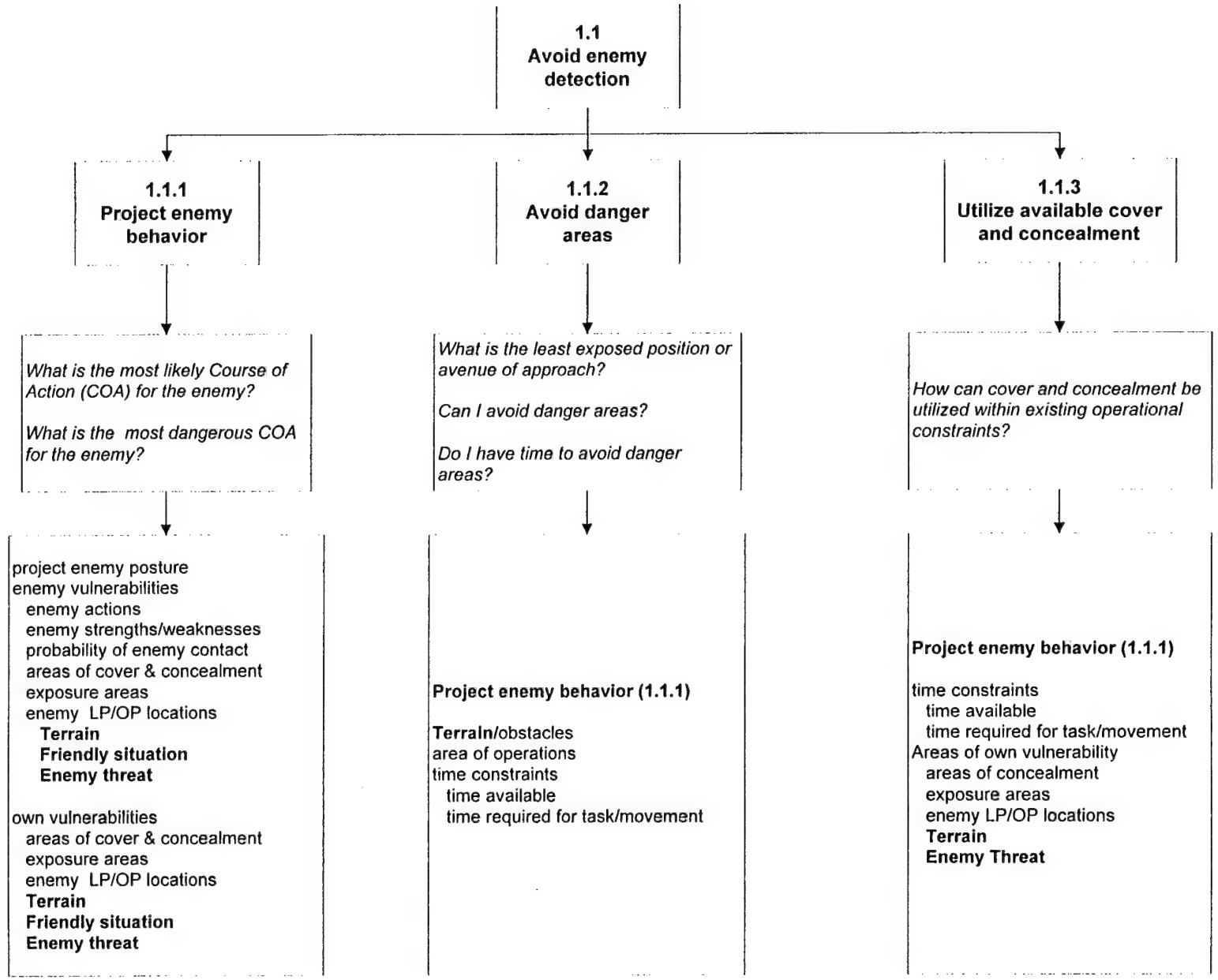
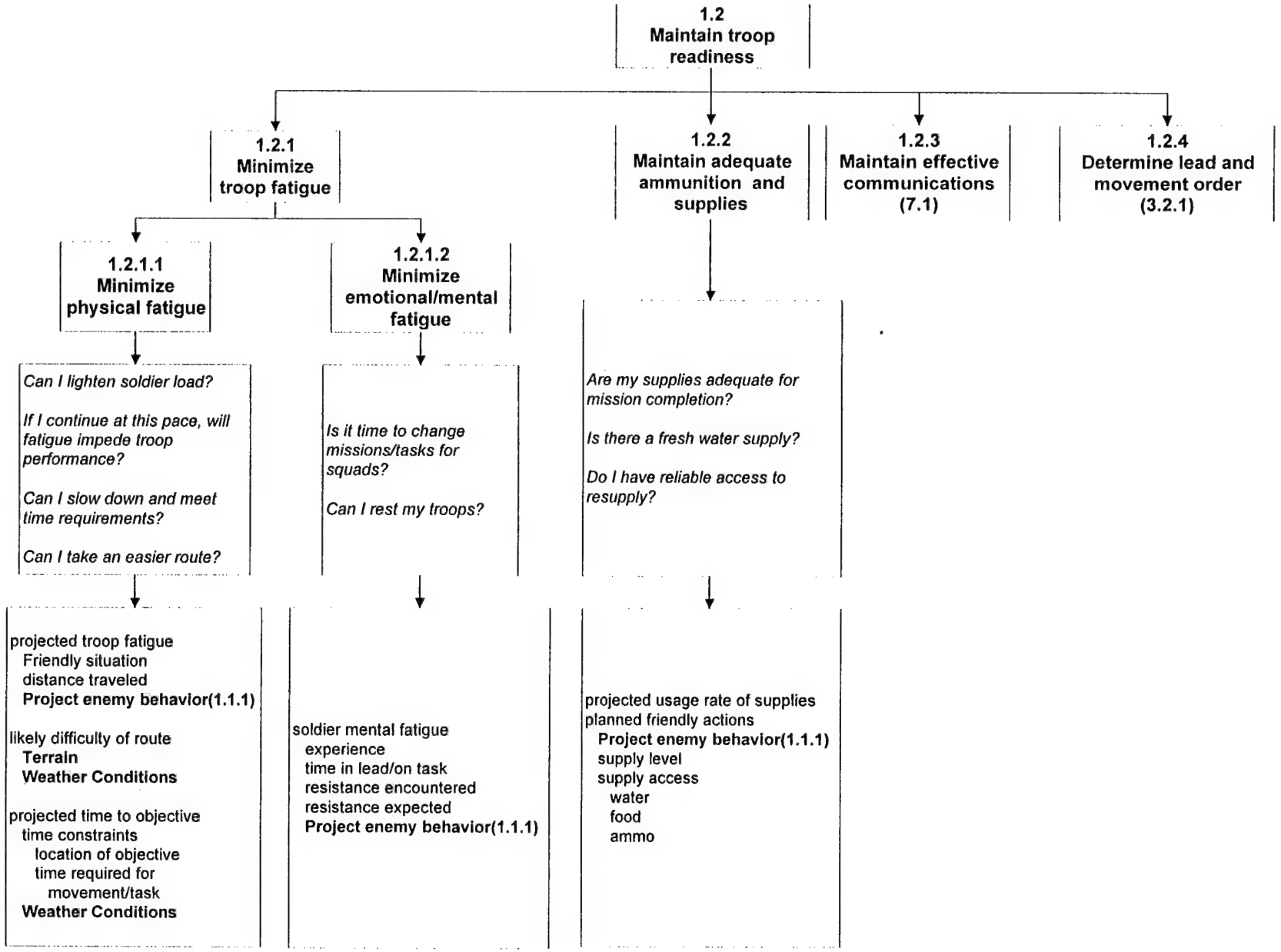
Appendix A: Detailed Results of the SA Requirements Analysis

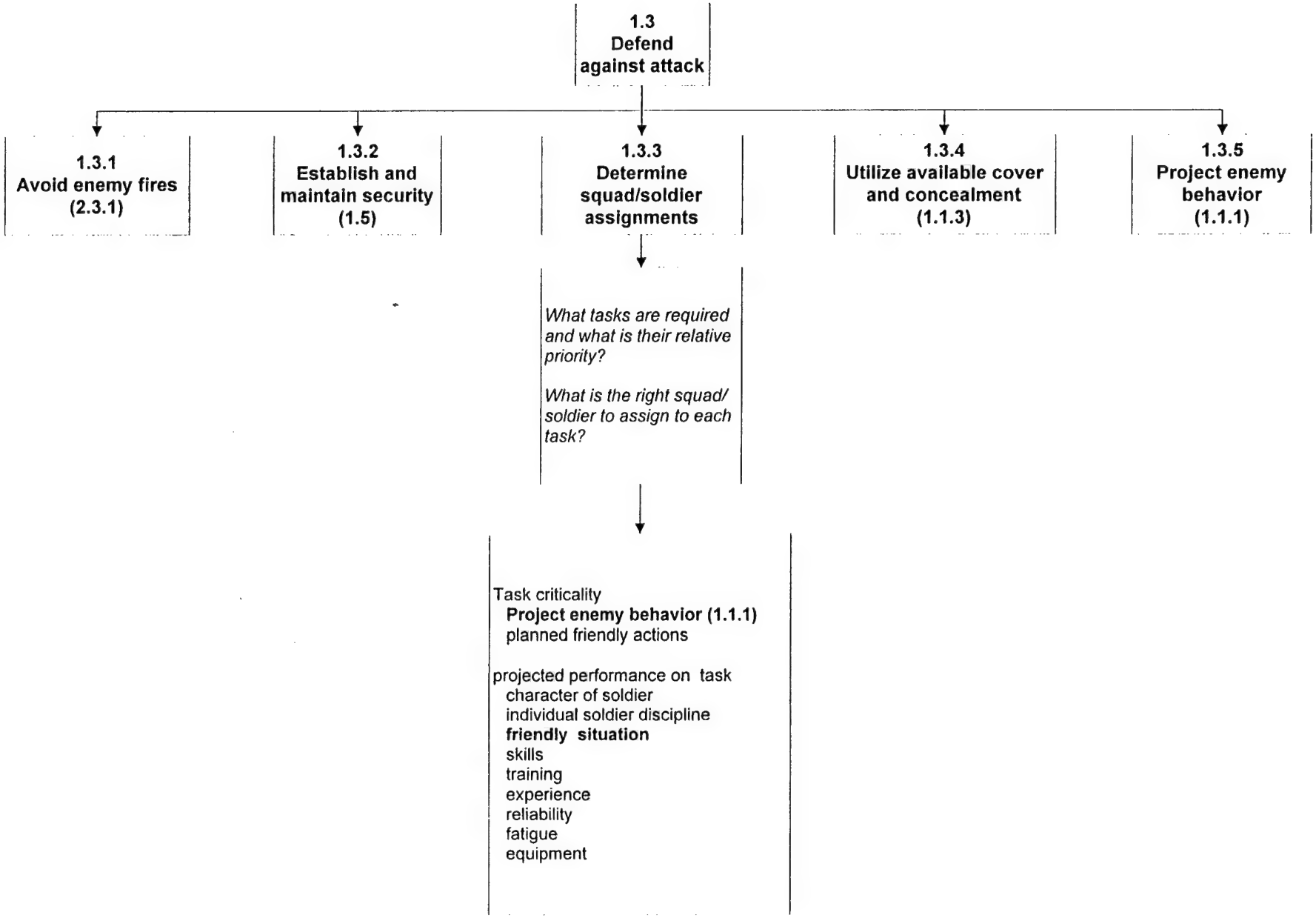
The chart shown on the following pages is the result of an SA Requirements Analysis for platoon leaders during a MOUT mission. The methods used to conduct this analysis and additional description of the results are given on pages 7 through 10 of the main report. The first page of the chart shows the hierarchical structure of the analysis, with Attack, Secure and Hold Terrain (0.0) as the overall objective. Seven primary goals, numbered 1.0 to 7.0, are listed beneath this objective, with secondary goals identified beneath each of the primary goals. These secondary goals share the whole number of the primary goal they fall below (i.e. items under goal 1.0 would be 1.1, 1.2, etc.). Subsequent pages each list one secondary goal with all subgoals commonly associated with the secondary goal. The final page of the requirements analysis shows six categories of SA needs, which SMEs identified as important in many situations. These are listed separately to avoid the redundancy of frequent repetition.

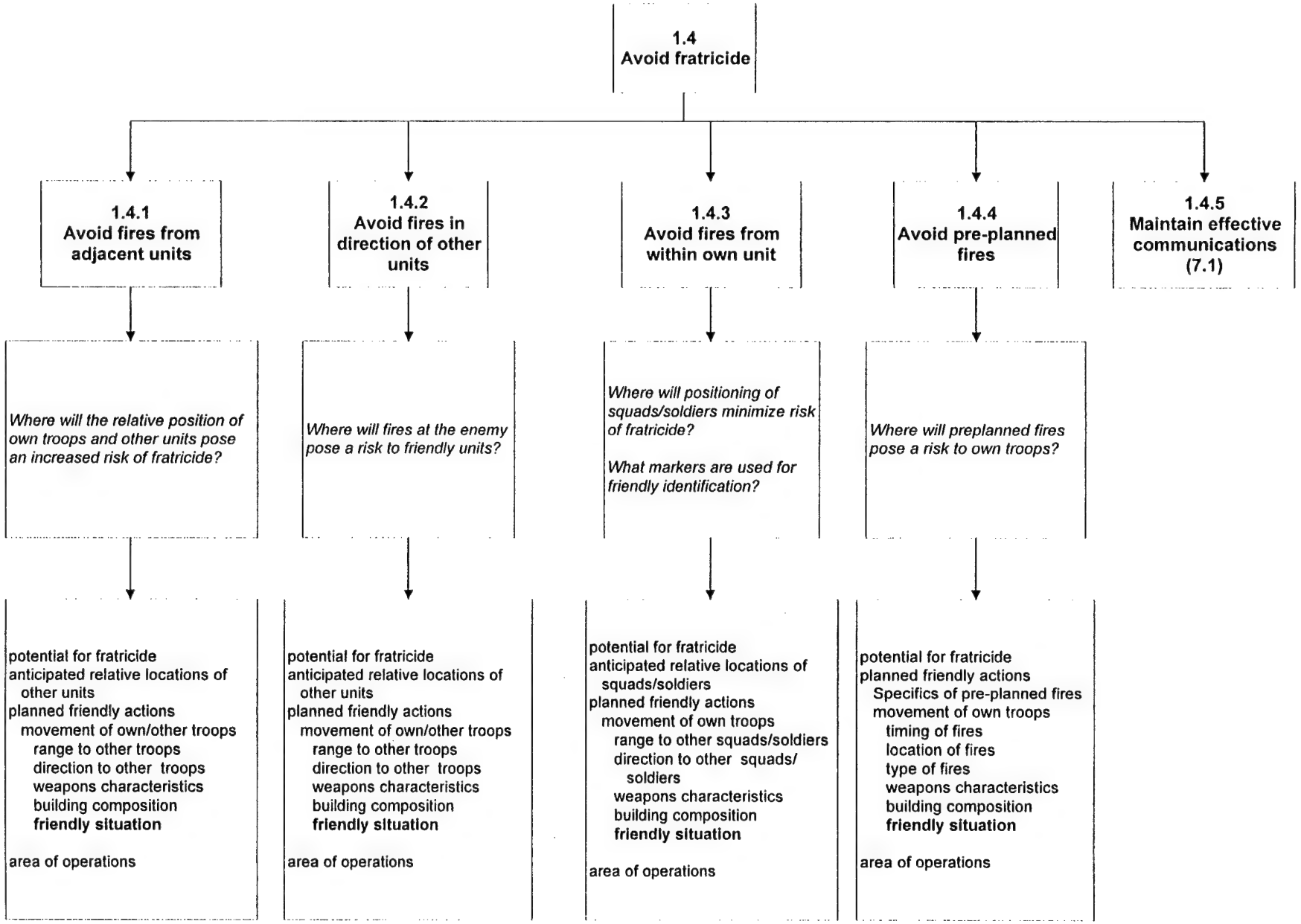
Each page that lists a secondary goal (A–3 to A–23) shows the secondary goal at the top of the page, with the subgoals listed directly beneath. Some subgoals are called into play in meeting more than one secondary goal. For brevity, subgoals that are listed under more than one secondary goal are only fully described in one location in the analysis. Where these subgoals are referred to on other pages, the subgoal number where the complete description can be found is shown in parentheses beneath the name of the subgoal. Below each subgoal is a box listing questions that platoon leaders might ask themselves to assist in meeting the subgoal. At the bottom of the page, beneath the questions, is a list of information that the platoon leader would like to have in order to answer the questions and meet the subgoal. Indentation of the SA information serves two functions: first as a general indicator of level of SA, with Level 3, projection, information flush against the left side of the box, Level 2, comprehension, information indented once, and Level 1, perception, information indented twice, and second to illustrate information that feeds into the higher level information processing required for the subgoal. Therefore, a Level 3 SA item could be indented once or even twice if it is used to develop another higher level comprehension or projection element more specific to the goal in question. In addition, items that are found in other portions of the requirements analysis are shown in bold. Therefore, items listed more completely in the categories on the final page of the analysis are shown in bold, as are references back to items listed under a different subgoal.

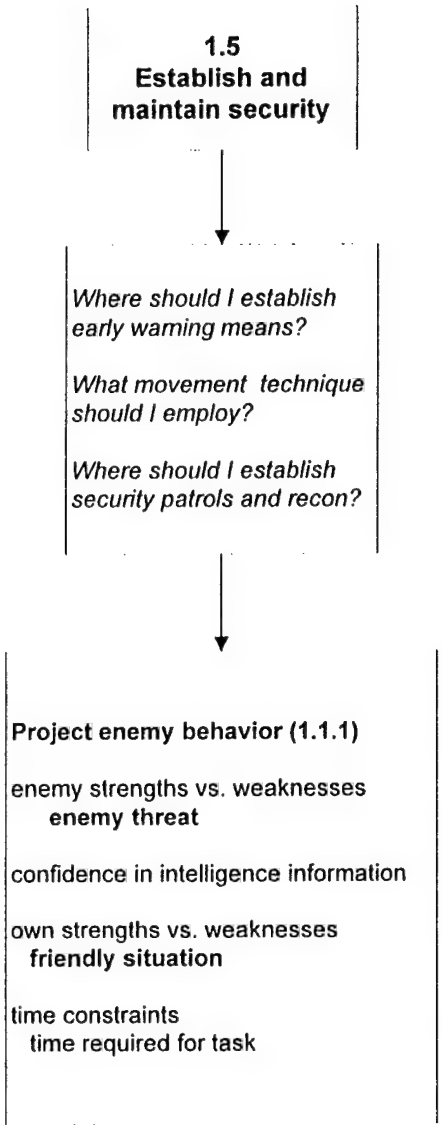

0.0
Attack, Secure and Hold Terrain
1.0
Avoid Casualties
1.1
Avoid enemy detection
1.2
Maintain troop readiness
1.3
Defend against attack
1.4
Avoid fratricide
1.5
Establish and maintain security
2.0
Negate Enemy Threat
2.1
Prioritize enemy threats
2.2
Make enemy position untenable
2.3
Obscure/ avoid enemy Field of Fire
2.4
Change enemy behavior
2.5
Engage enemy
2.6
Clear room/ building
3.0
Movement: Reach point X by time Y
3.1
Determine route
3.2
Determine formation / order of movement
4.0
Assault Through Objective
4.1
Plan/modify plan to accomplish mission
4.2
Consolidate/ Reorganize
5.0
Hold Objective
5.1
Prepare for enemy counterattack
5.2
Defend against attack (1.3)
6.0
Provide Stability and Support Operations (SASO)
6.1
Establish and maintain order
6.2
Protect/defend civilians
6.3
Perform civic improvements
7.0
Function in a team environment
7.1
Maintain effective communications
7.2
Support other platoons/ elements

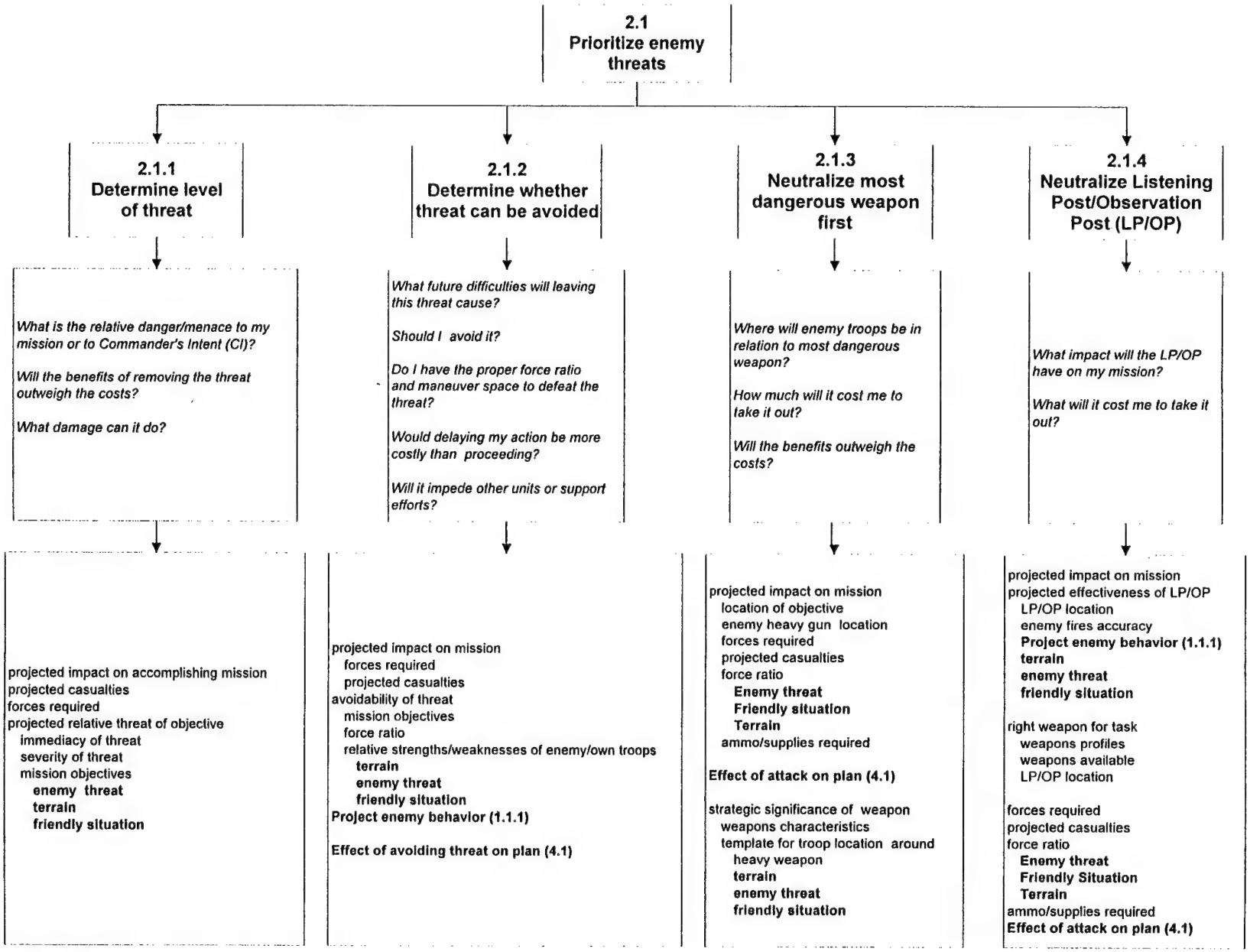

1.1
Avoid enemy detection
1.1.1
Project enemy behavior
1.1.2
Avoid danger areas
1.1.3
Utilize available cover and concealment
What is the most likely Course of Action (COA) for the enemy?
What is the most dangerous COA for the enemy?
What is the least exposed position or avenue of approach?
Can I avoid danger areas?
Do I have time to avoid danger areas?
How can cover and concealment be utilized within existing operational constraints?
project enemy posture
enemy vulnerabilities
enemy actions
enemy strengths/weaknesses
probability of enemy contact
areas of cover & concealment
exposure areas
enemy LP/OP locations
Terrain
Friendly situation
Enemy threat
own vulnerabilities
areas of cover & concealment
exposure areas
enemy LP/OP locations
Terrain
Friendly situation
Enemy threat
Project enemy behavior (1.1.1)
Terrain/obstacles
area of operations
time constraints
time available
time required for task/movement
Project enemy behavior (1.1.1)
time constraints
time available
time required for task/movement
Areas of own vulnerability
areas of concealment
exposure areas
enemy LP/OP locations
Terrain
Enemy Threat

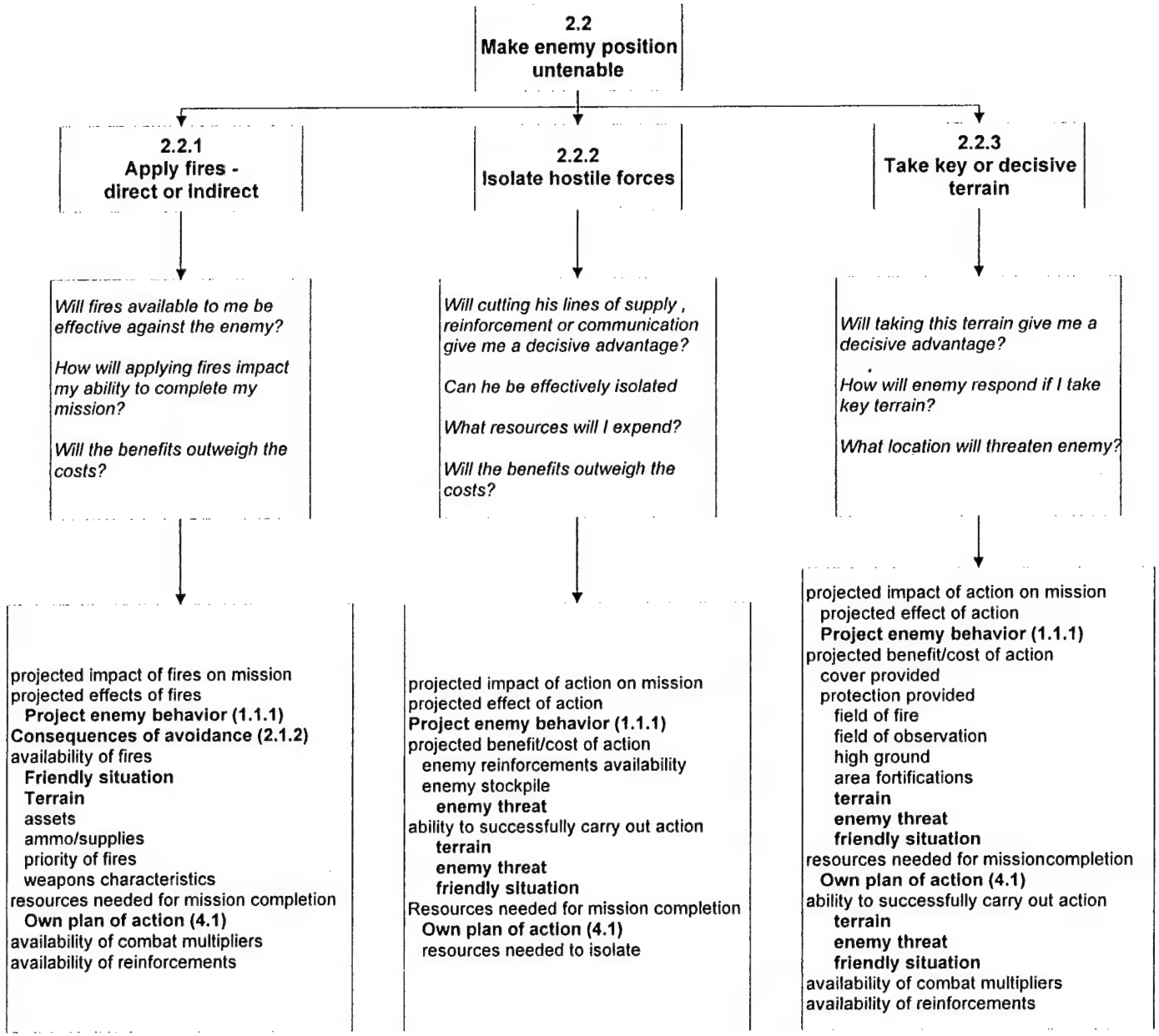

1.2
Maintain troop readiness
1.2.1
Minimize troop fatigue
1.2.2
Maintain adequate ammunition and supplies
1.2.3
Maintain effective communications (7.1)
1.2.4
Determine lead and movement order (3.2.1)
1.2.1.1
Minimize physical fatigue
1.2.1.2
Minimize emotional/mental fatigue
Can I lighten soldier load?
If I continue at this pace, will fatigue impede troop performance?
Can I slow down and meet time requirements?
Can I take an easier route?
Is it time to change missions/tasks for squads?
Can I rest my troops?
Are my supplies adequate for mission completion?
Is there a fresh water supply?
Do I have reliable access to resupply?
projected troop fatigue
Friendly situation
distance traveled
Project enemy behavior(1.1.1)
likely difficulty of route
Terrain
Weather Conditions
projected time to objective
time constraints
location of objective
time required for movement/task
Weather Conditions
soldier mental fatigue
experience
time in lead/on task
resistance encountered
resistance expected
Project enemy behavior(1.1.1)
projected usage rate of supplies
planned friendly actions
Project enemy behavior(1.1.1)
supply level
supply access
water
food
ammo

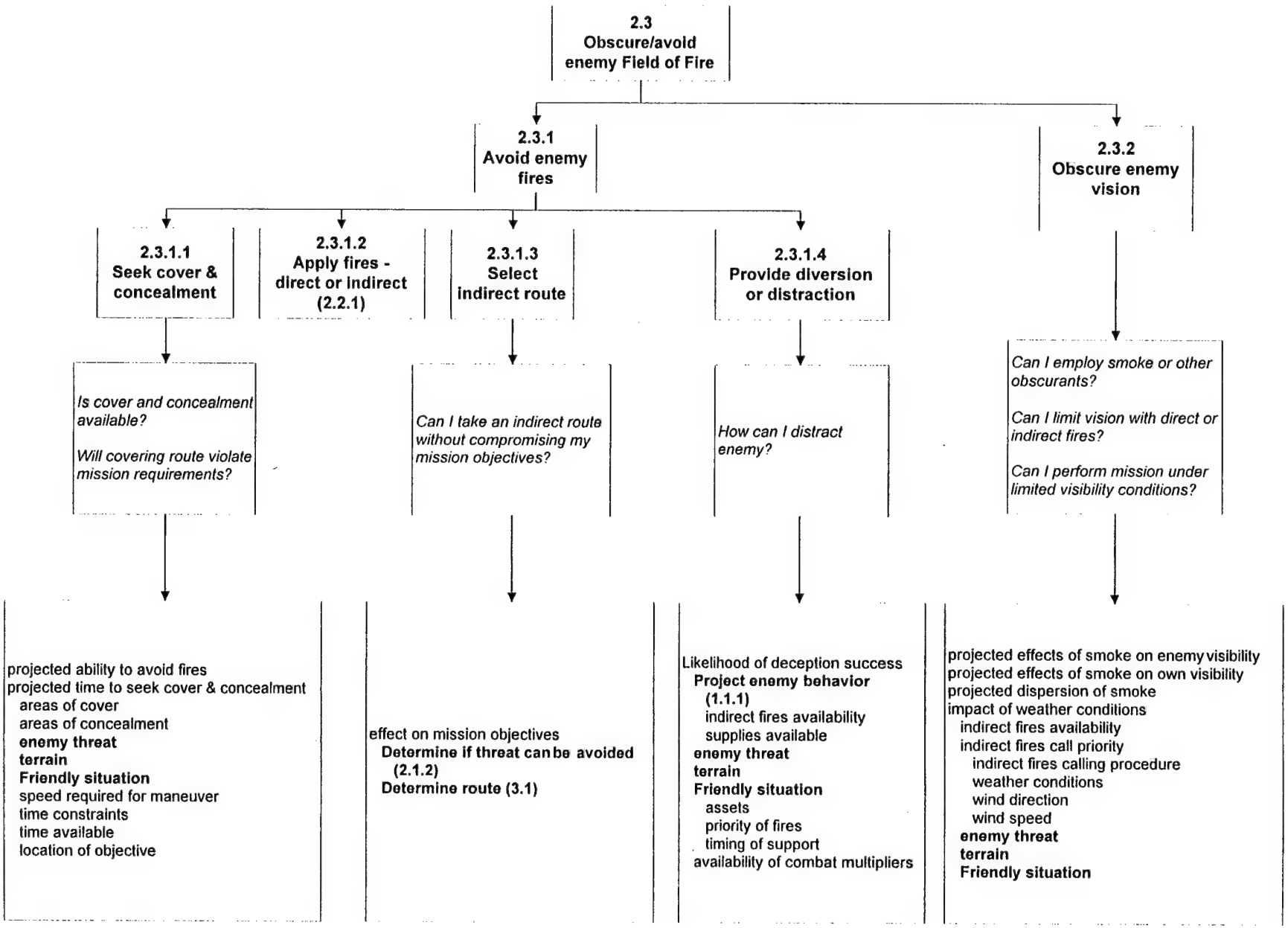

1.3
Defend against attack
1.3.1
Avoid enemy fires (2.3.1)
1.3.2
Establish and maintain security (1.5)
1.3.3
Determine squad/soldier assignments
1.3.4
Utilize available cover and concealment (1.1.3)
1.3.5
Project enemy behavior (1.1.1)
What tasks are required and what is their relative priority?
What is the right squad/ soldier to assign to each task?
Task criticality
Project enemy behavior (1.1.1)
planned friendly actions
projected performance on task
character of soldier
individual soldier discipline
friendly situation
skills
training
experience
reliability
fatigue
equipment

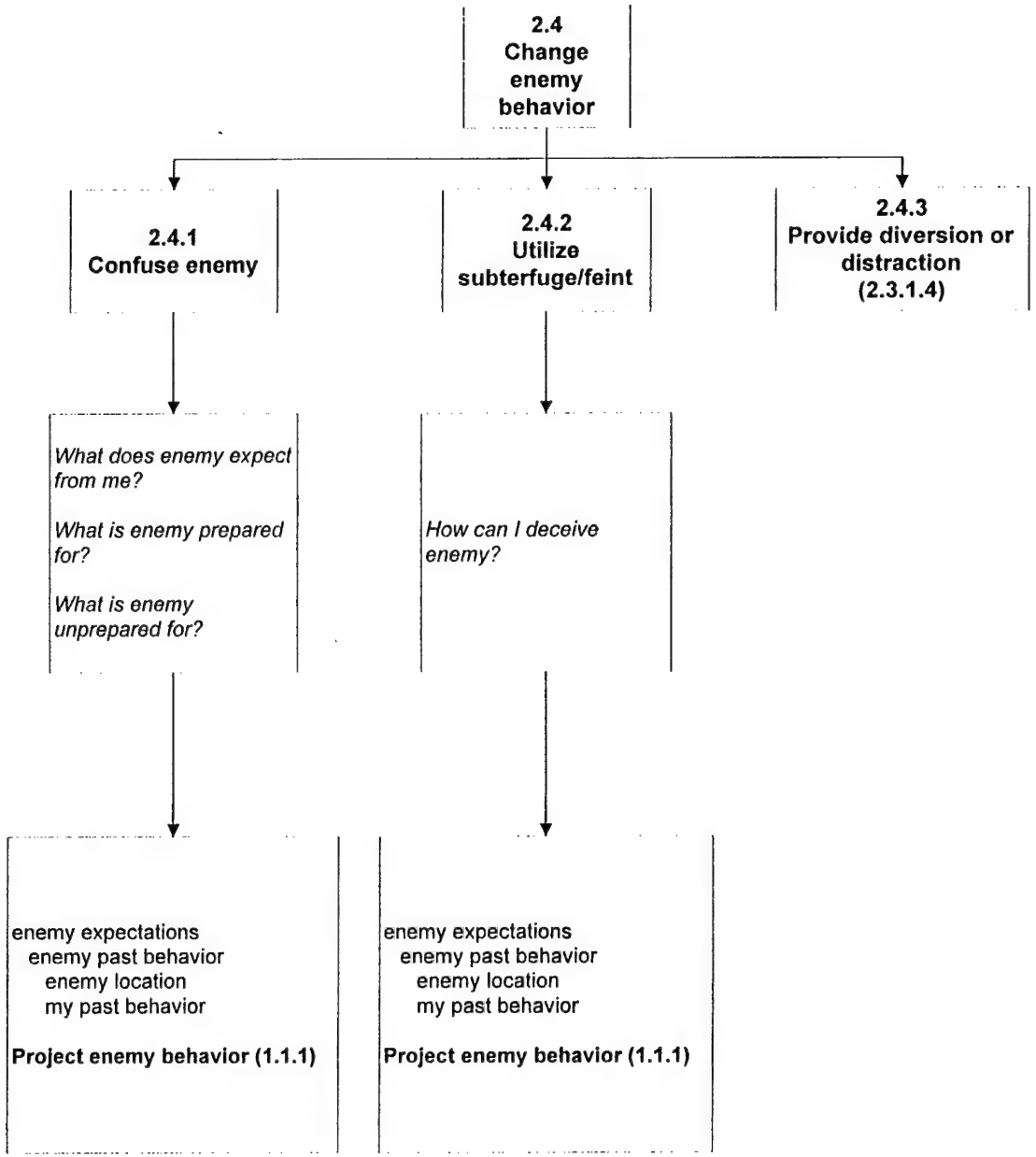

1.4
Avoid fratricide
1.4.1
Avoid fires from adjacent units
1.4.2
Avoid fires in direction of other units
1.4.3
Avoid fires from within own unit
1.4.4
Avoid pre-planned fires
1.4.5
Maintain effective communications (7.1)
Where will the relative position of own troops and other units pose an increased risk of fratricide?
Where will fires at the enemy pose a risk to friendly units?
Where will positioning of squads/soldiers minimize risk of fratricide?
What markers are used for friendly identification?
Where will preplanned fires pose a risk to own troops?
potential for fratricide
anticipated relative locations of other units
planned friendly actions
movement of own/other troops
range to other troops
direction to other troops
weapons characteristics
building composition
friendly situation
area of operations
potential for fratricide
anticipated relative locations of other units
planned friendly actions
movement of own/other troops
range to other troops
direction to other troops
weapons characteristics
building composition
friendly situation
area of operations
potential for fratricide
anticipated relative locations of squads/soldiers
planned friendly actions
movement of own troops
range to other squads/soldiers
direction to other squads/soldiers
weapons characteristics
building composition
friendly situation
area of operations
potential for fratricide
planned friendly actions
Specifics of pre-planned fires
movement of own troops
timing of fires
location of fires
type of fires
weapons characteristics
building composition
friendly situation
area of operations

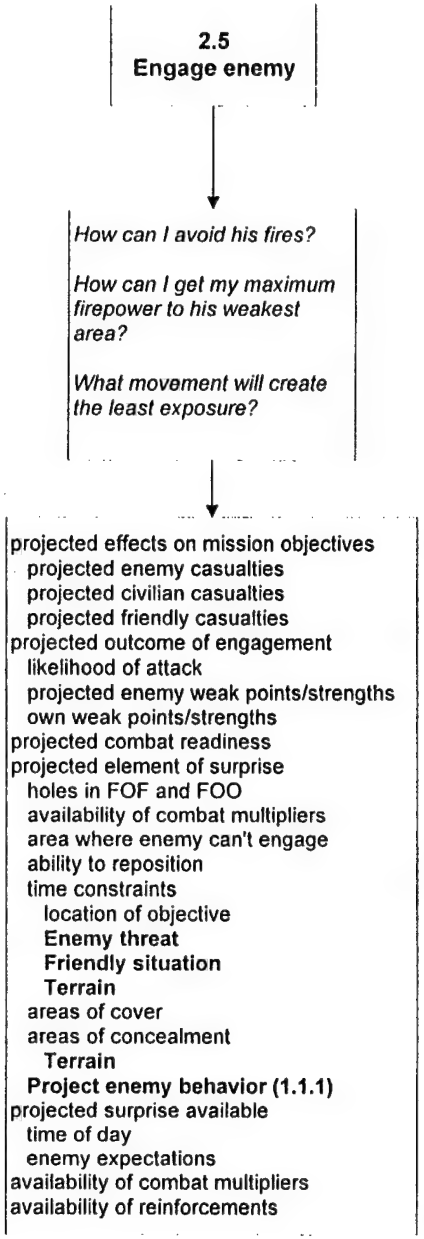

1.5
Establish and
maintain security
Where should I establish early warning means?
What movement technique should I employ?
Where should I establish security patrols and recon?
Project enemy behavior (1.1.1)
enemy strengths vs. weaknesses
enemy threat
confidence in intelligence information
own strengths vs. weaknesses
friendly situation
time constraints
time required for task

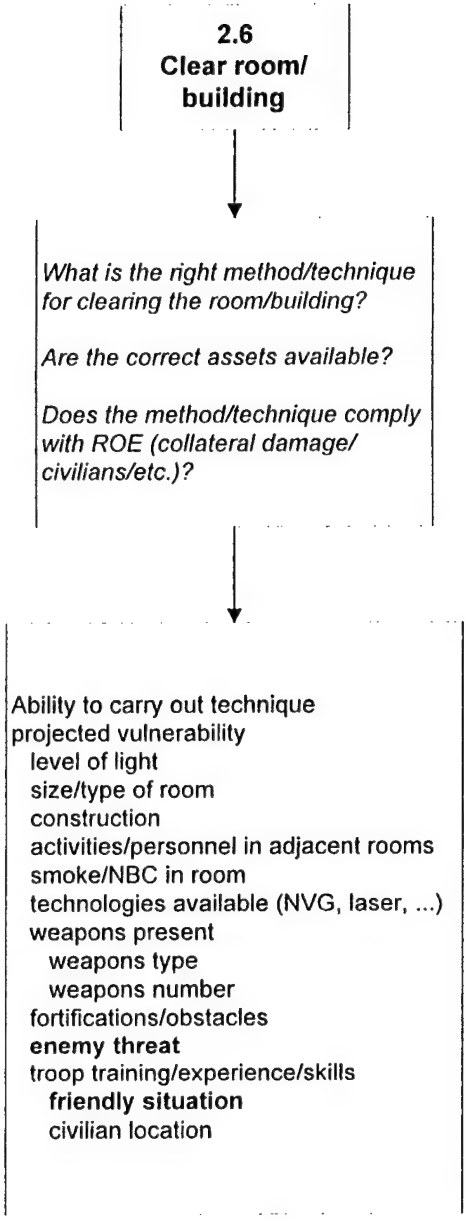

2.1
Prioritize enemy threats
2.1.1
Determine level of threat
2.1.2
Determine whether threat can be avoided
2.1.3
Neutralize most dangerous weapon first
2.1.4
Neutralize Listening Post/Observation Post (LP/OP)
What is the relative danger/menace to my mission or to Commander's Intent (CI)?
Will the benefits of removing the threat outweigh the costs?
What damage can it do?
What future difficulties will leaving this threat cause?
Should I avoid it?
Do I have the proper force ratio and maneuver space to defeat the threat?
Would delaying my action be more costly than proceeding?
Will it impede other units or support efforts?
Where will enemy troops be in relation to most dangerous weapon?
How much will it cost me to take it out?
Will the benefits outweigh the costs?
What impact will the LP/OP have on my mission?
What will it cost me to take it out?
projected impact on accomplishing mission
projected casualties
forces required
projected relative threat of objective
immediacy of threat
severity of threat
mission objectives
enemy threat
terrain
friendly situation
projected impact on mission
forces required
projected casualties
avoidability of threat
mission objectives
force ratio
relative strengths/weaknesses of enemy/own troops
terrain
enemy threat
friendly situation
Project enemy behavior (1.1.1)
Effect of avoiding threat on plan (4.1)
projected impact on mission
location of objective
enemy heavy gun location
forces required
projected casualties
force ratio
Enemy threat
Friendly situation
Terrain
ammo/supplies required
Effect of attack on plan (4.1)
strategic significance of weapon
weapons characteristics
template for troop location around
heavy weapon
terrain
enemy threat
friendly situation
projected impact on mission
projected effectiveness of LP/OP
LP/OP location
enemy fires accuracy
Project enemy behavior (1.1.1)
terrain
enemy threat
friendly situation
right weapon for task
weapons profiles
weapons available
LP/OP location
forces required
projected casualties
force ratio
Enemy threat
Friendly Situation
Terrain
ammo/supplies required
Effect of attack on plan (4.1)

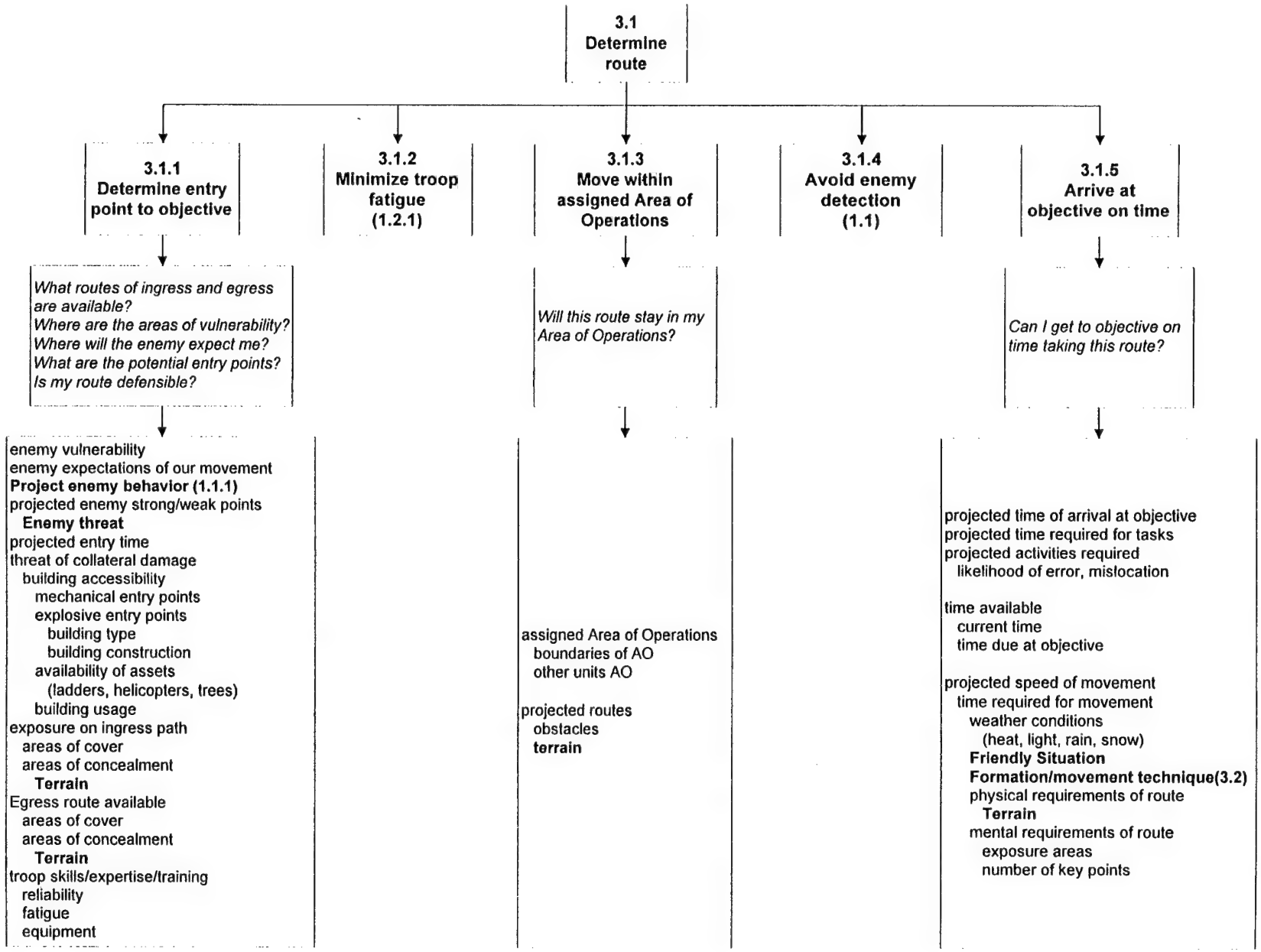

2.2
Make enemy position untenable
2.2.1
Apply fires - direct or indirect
2.2.2
Isolate hostile forces
2.2.3
Take key or decisive terrain
Will fires available to me be effective against the enemy?
How will applying fires impact my ability to complete my mission?
Will the benefits outweigh the costs?
Will cutting his lines of supply , reinforcement or communication give me a decisive advantage?
Can he be effectively isolated
What resources will I expend?
Will the benefits outweigh the costs?
Will taking this terrain give me a decisive advantage?
How will enemy respond if I take key terrain?
What location will threaten enemy?
projected impact of fires on mission
projected effects of fires
Project enemy behavior (1.1.1)
Consequences of avoidance (2.1.2)
availability of fires
Friendly situation
Terrain
assets
ammo/supplies
priority of fires
weapons characteristics
resources needed for mission completion
Own plan of action (4.1)
availability of combat multipliers
availability of reinforcements
projected impact of action on mission
projected effect of action
Project enemy behavior (1.1.1)
projected benefit/cost of action
enemy reinforcements availability
enemy stockpile
enemy threat
ability to successfully carry out action
terrain
enemy threat
friendly situation
Resources needed for mission completion
Own plan of action (4.1)
resources needed to isolate
projected impact of action on mission
projected effect of action
Project enemy behavior (1.1.1)
projected benefit/cost of action
cover provided
protection provided
field of fire
field of observation
high ground
area fortifications
terrain
enemy threat
friendly situation
resources needed for missioncompletion
Own plan of action (4.1)
ability to successfully carry out action
terrain
enemy threat
friendly situation
availability of combat multipliers
availability of reinforcements

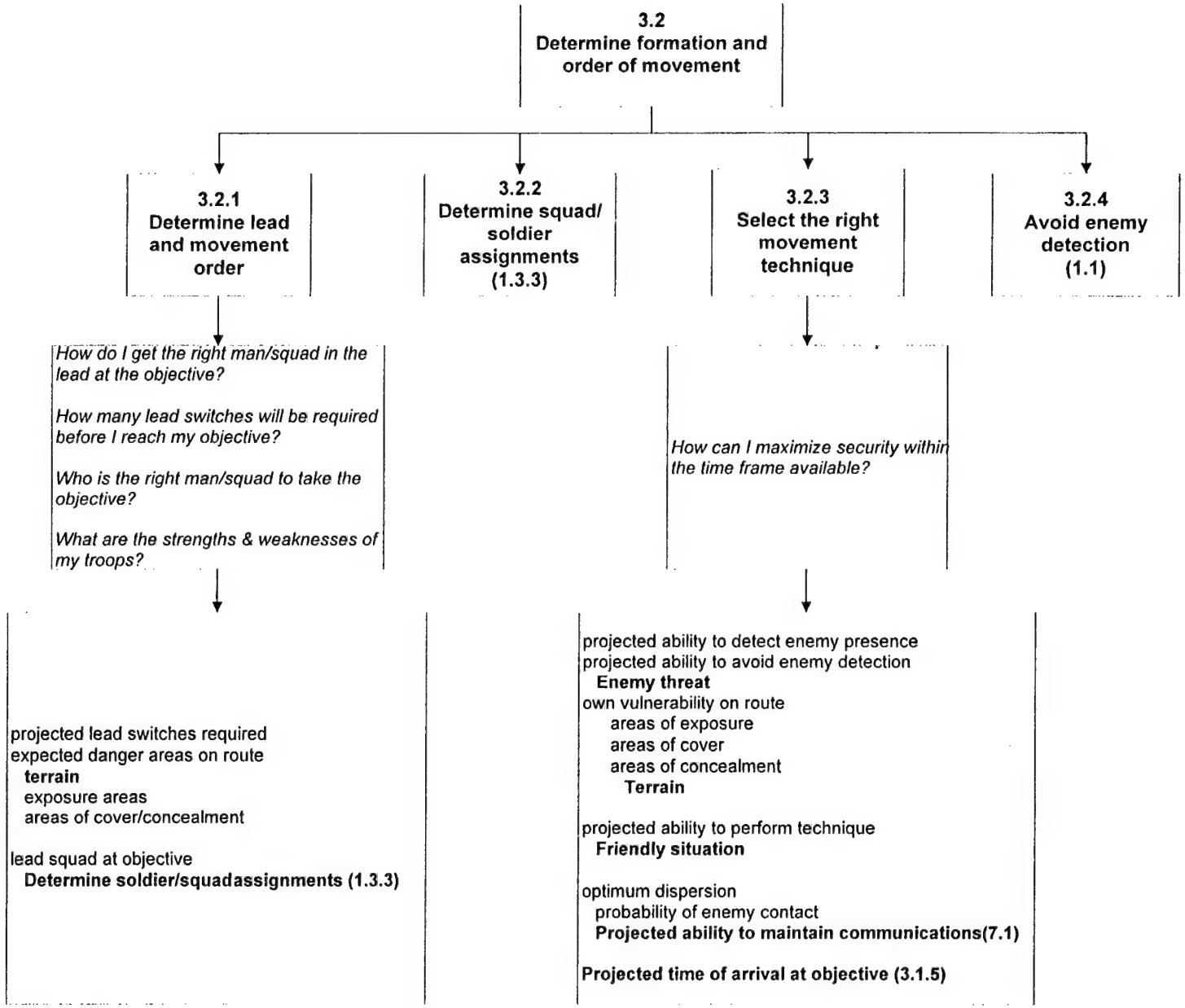

2.3
Obscure/avoid enemy Field of Fire
2.3.1
Avoid enemy fires
2.3.2
Obscure enemy vision
2.3.1.1
Seek cover & concealment
2.3.1.2
Apply fires - direct or indirect (2.2.1)
2.3.1.3
Select indirect route
2.3.1.4
Provide diversion or distraction
Is cover and concealment available?
Will covering route violate mission requirements?
Can I take an indirect route without compromising my mission objectives?
How can I distract enemy?
Can I employ smoke or other obscurants?
Can I limit vision with direct or indirect fires?
Can I perform mission under limited visibility conditions?
projected ability to avoid fires
projected time to seek cover & concealment
areas of cover
areas of concealment
enemy threat
terrain
Friendly situation
speed required for maneuver
time constraints
time available
location of objective
effect on mission objectives
Determine if threat can be avoided (2.1.2)
Determine route (3.1)
Likelihood of deception success
Project enemy behavior (1.1.1)
indirect fires availability
supplies available
enemy threat
terrain
Friendly situation
assets
priority of fires
timing of support
availability of combat multipliers
projected effects of smoke on enemy visibility
projected effects of smoke on own visibility
projected dispersion of smoke
impact of weather conditions
indirect fires availability
indirect fires call priority
indirect fires calling procedure
weather conditions
wind direction
wind speed
enemy threat
terrain
Friendly situation

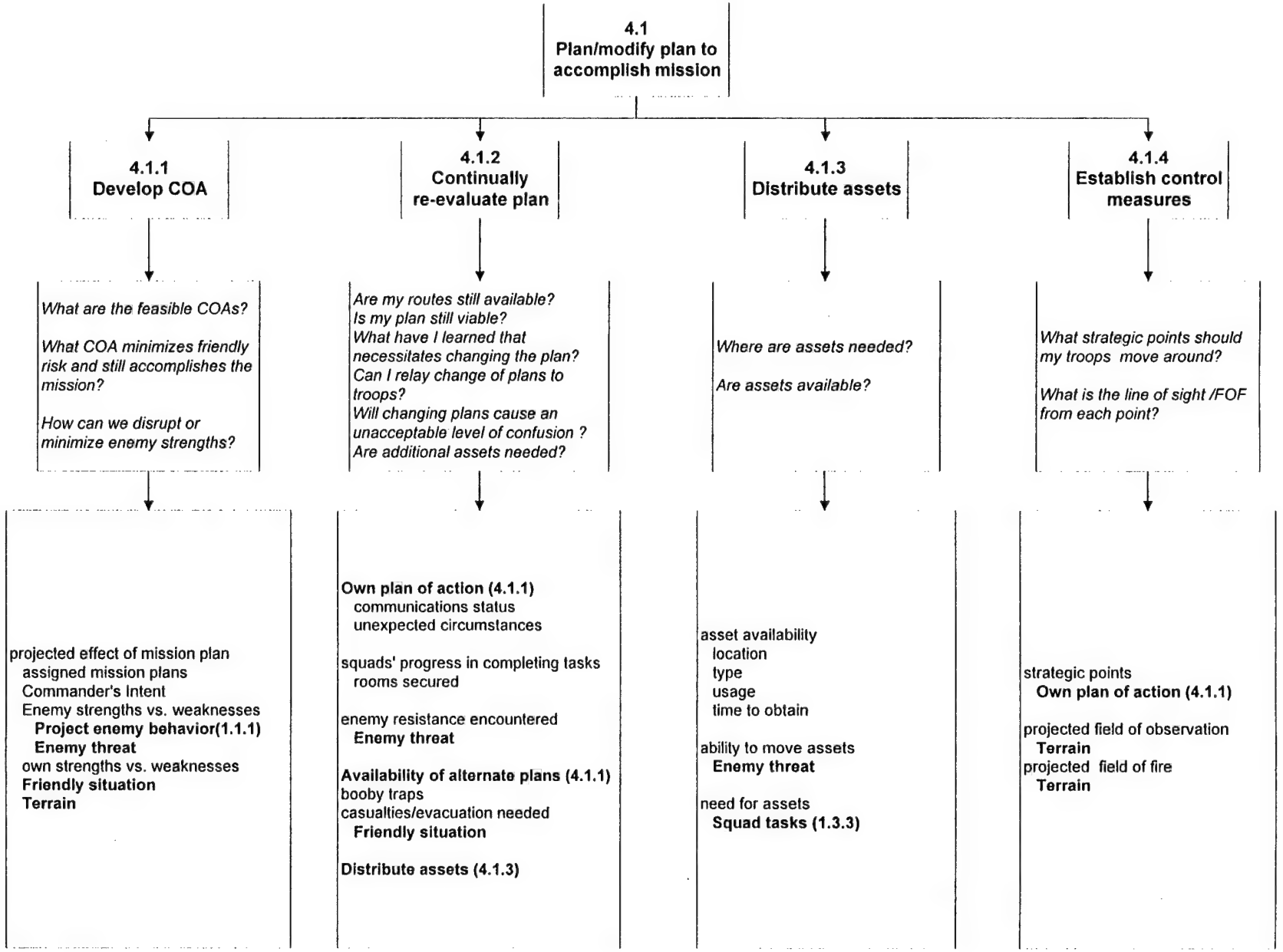

2.4
Change
enemy
behavior
2.4.1
Confuse enemy
2.4.2
Utilize
subterfuge/feint
2.4.3
Provide diversion or
distraction
(2.3.1.4)
What does enemy expect
from me?
What is enemy prepared
for?
What is enemy
unprepared for?
How can I deceive
enemy?
enemy expectations
enemy past behavior
enemy location
my past behavior
Project enemy behavior (1.1.1)
enemy expectations
enemy past behavior
enemy location
my past behavior
Project enemy behavior (1.1.1)

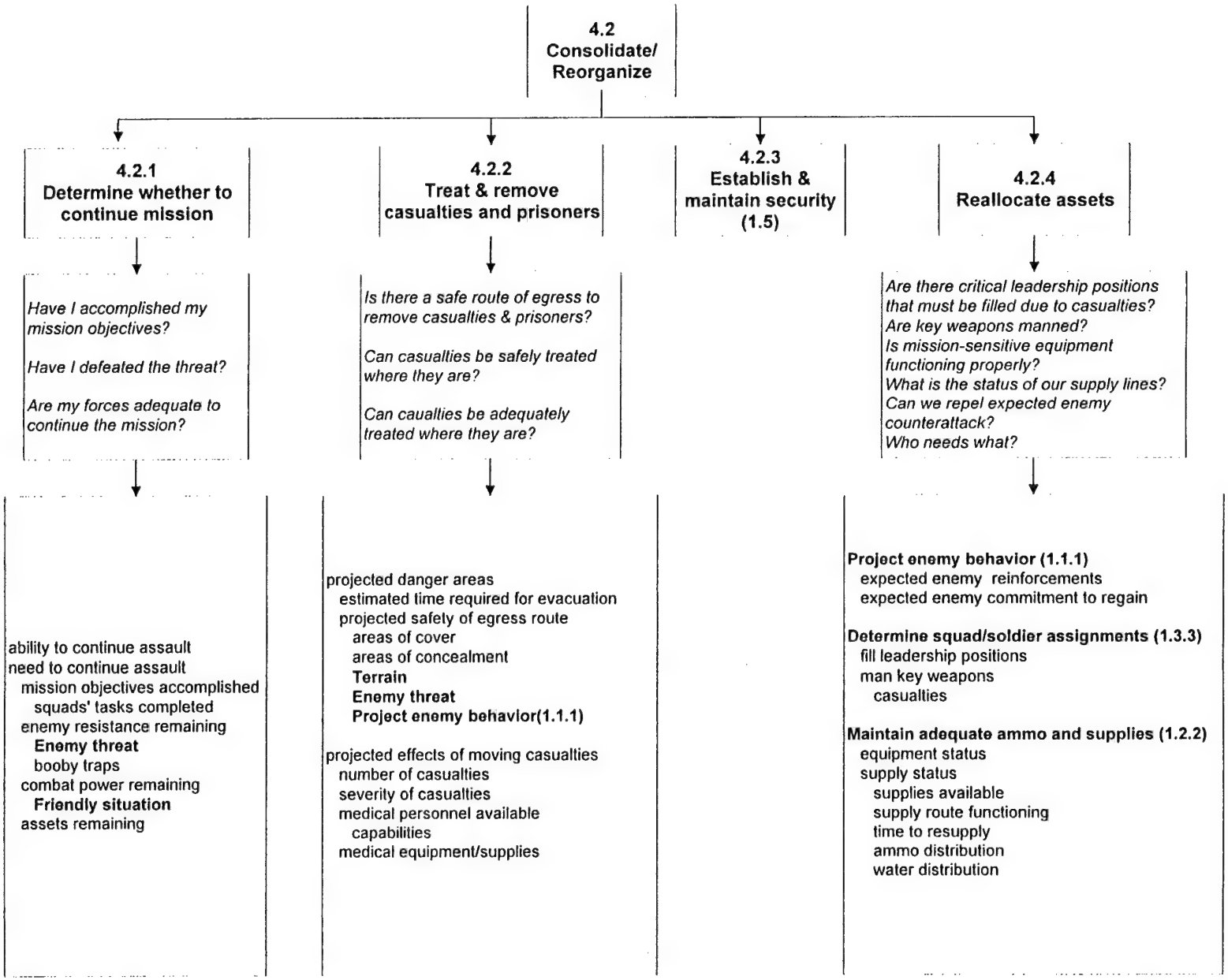

2.5
Engage enemy
How can I avoid his fires?
How can I get my maximum firepower to his weakest area?
What movement will create the least exposure?
projected effects on mission objectives
projected enemy casualties
projected civilian casualties
projected friendly casualties
projected outcome of engagement
likelihood of attack
projected enemy weak points/strengths
own weak points/strengths
projected combat readiness
projected element of surprise
holes in FOF and FOO
availability of combat multipliers
area where enemy can't engage
ability to reposition
time constraints
location of objective
Enemy threat
Friendly situation
Terrain
areas of cover
areas of concealment
Terrain
Project enemy behavior (1.1.1)
projected surprise available
time of day
enemy expectations
availability of combat multipliers
availability of reinforcements

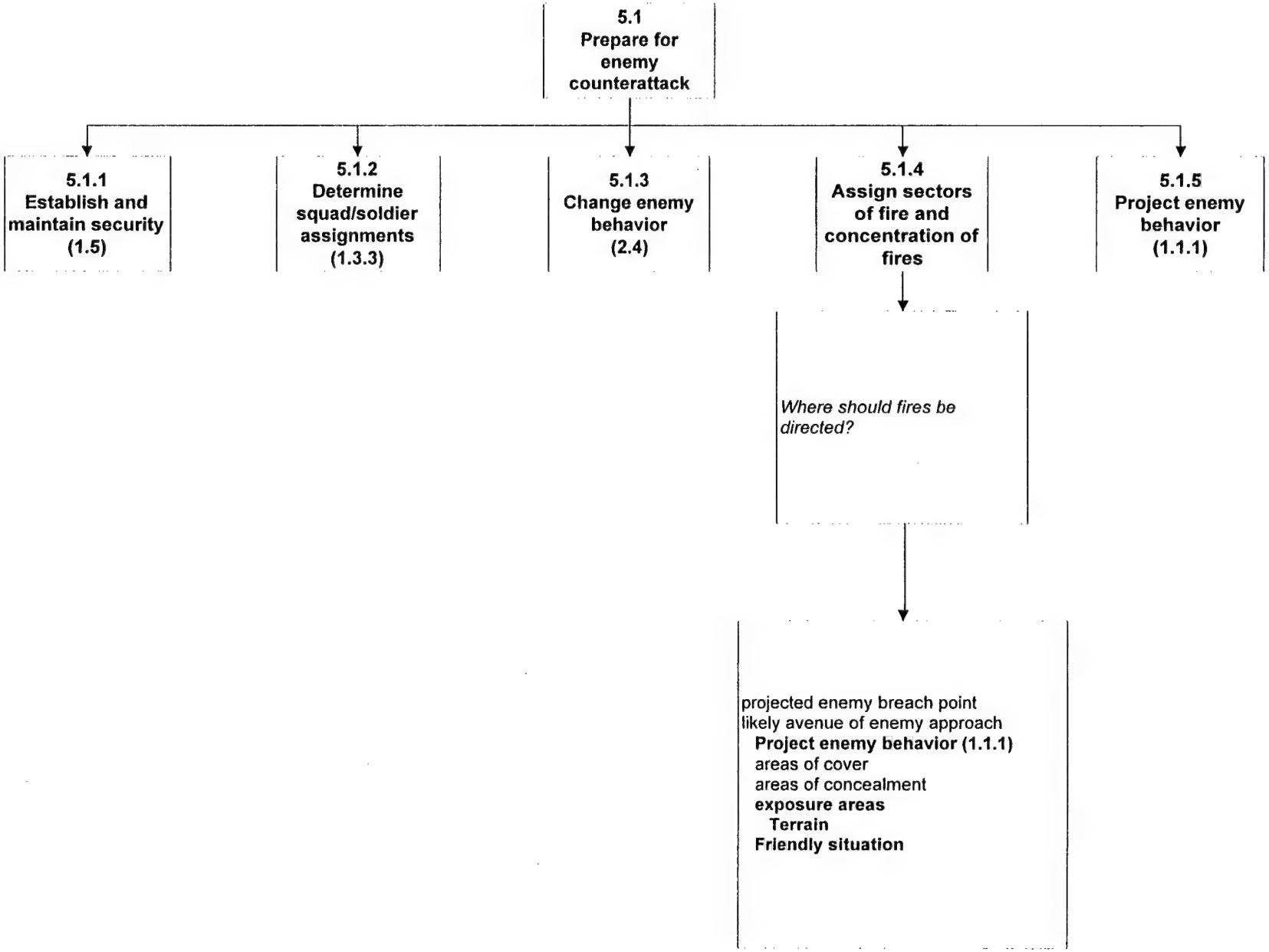

2.6
Clear room/
building
What is the right method/technique for clearing the room/building?
Are the correct assets available?
Does the method/technique comply with ROE (collateral damage/ civilians/etc.)?
Ability to carry out technique
projected vulnerability
level of light
size/type of room
construction
activities/personnel in adjacent rooms
smoke/NBC in room
technologies available (NVG, laser, ...)
weapons present
weapons type
weapons number
fortifications/obstacles
enemy threat
troop training/experience/skills
friendly situation
civilian location

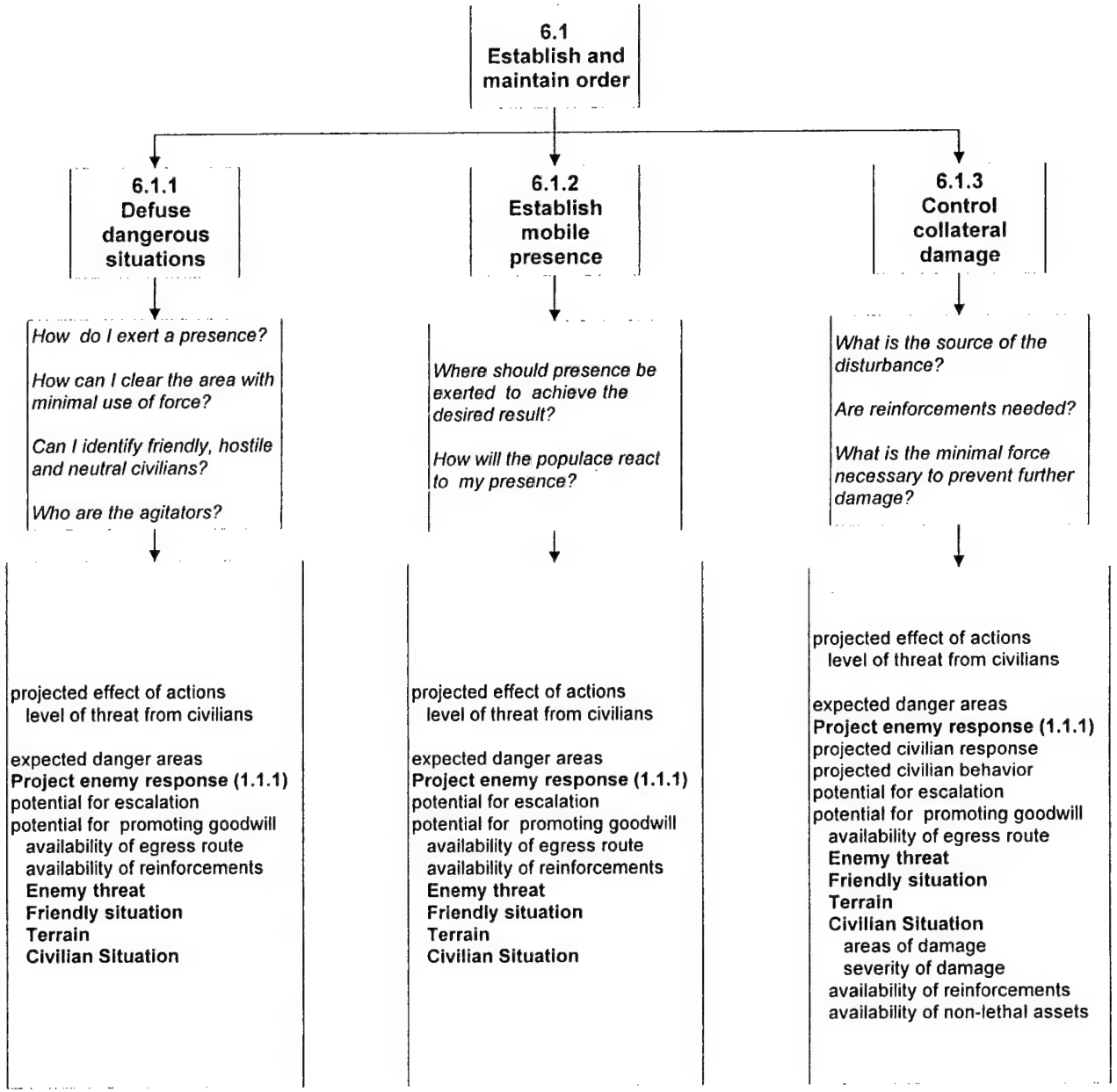

3.1 Determine route
3.1.1 Determine entry point to objective
3.1.2 Minimize troop fatigue (1.2.1)
3.1.3 Move within assigned Area of Operations
3.1.4 Avoid enemy detection (1.1)
3.1.5 Arrive at objective on time
What routes of ingress and egress are available?
Where are the areas of vulnerability?
Where will the enemy expect me?
What are the potential entry points?
Is my route defensible?
Will this route stay in my Area of Operations?
Can I get to objective on time taking this route?
enemy vulnerability
enemy expectations of our movement
Project enemy behavior (1.1.1)
projected enemy strong/weak points
Enemy threat
projected entry time
threat of collateral damage
building accessibility
mechanical entry points
explosive entry points
building type
building construction
availability of assets
(ladders, helicopters, trees)
building usage
exposure on ingress path
areas of cover
areas of concealment
Terrain
Egress route available
areas of cover
areas of concealment
Terrain
troop skills/expertise/training
reliability
fatigue
equipment
assigned Area of Operations
boundaries of AO
other units AO
projected routes
obstacles
terrain
projected time of arrival at objective
projected time required for tasks
projected activities required
likelihood of error, mislocation
time available
current time
time due at objective
projected speed of movement
time required for movement
weather conditions
(heat, light, rain, snow)
Friendly Situation
Formation/movement technique(3.2)
physical requirements of route
Terrain
mental requirements of route
exposure areas
number of key points

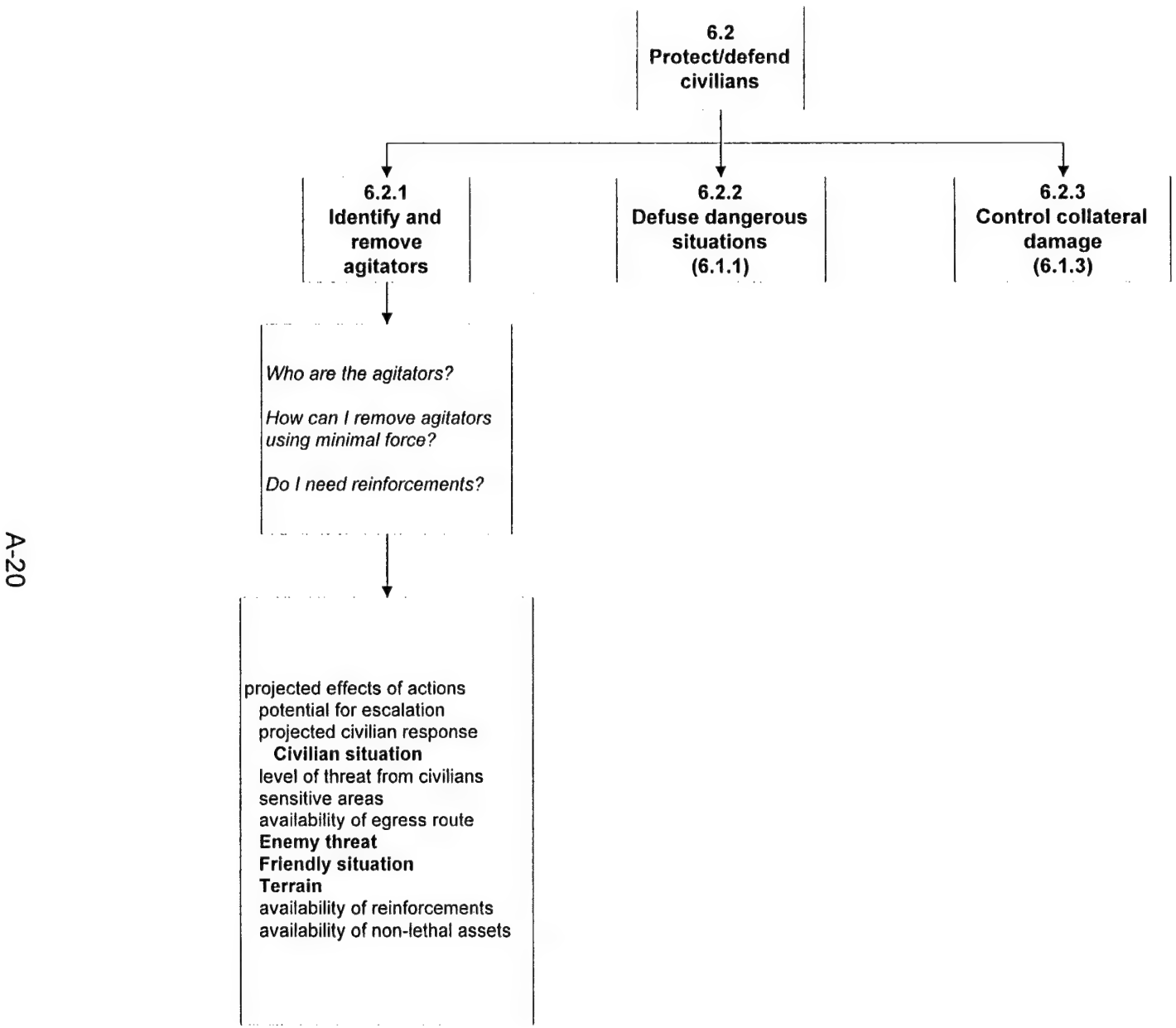

3.2
Determine formation and order of movement
3.2.1
Determine lead and movement order
3.2.2
Determine squad/ soldier assignments (1.3.3)
3.2.3
Select the right movement technique
3.2.4
Avoid enemy detection (1.1)
How do I get the right man/squad in the lead at the objective?
How many lead switches will be required before I reach my objective?
Who is the right man/squad to take the objective?
What are the strengths & weaknesses of my troops?
How can I maximize security within the time frame available?
projected lead switches required
expected danger areas on route
terrain
exposure areas
areas of cover/concealment
lead squad at objective
Determine soldier/squadassignments (1.3.3)
projected ability to detect enemy presence
projected ability to avoid enemy detection
Enemy threat
own vulnerability on route
areas of exposure
areas of cover
areas of concealment
Terrain
projected ability to perform technique
Friendly situation
optimum dispersion
probability of enemy contact
Projected ability to maintain communications(7.1)
Projected time of arrival at objective (3.1.5)

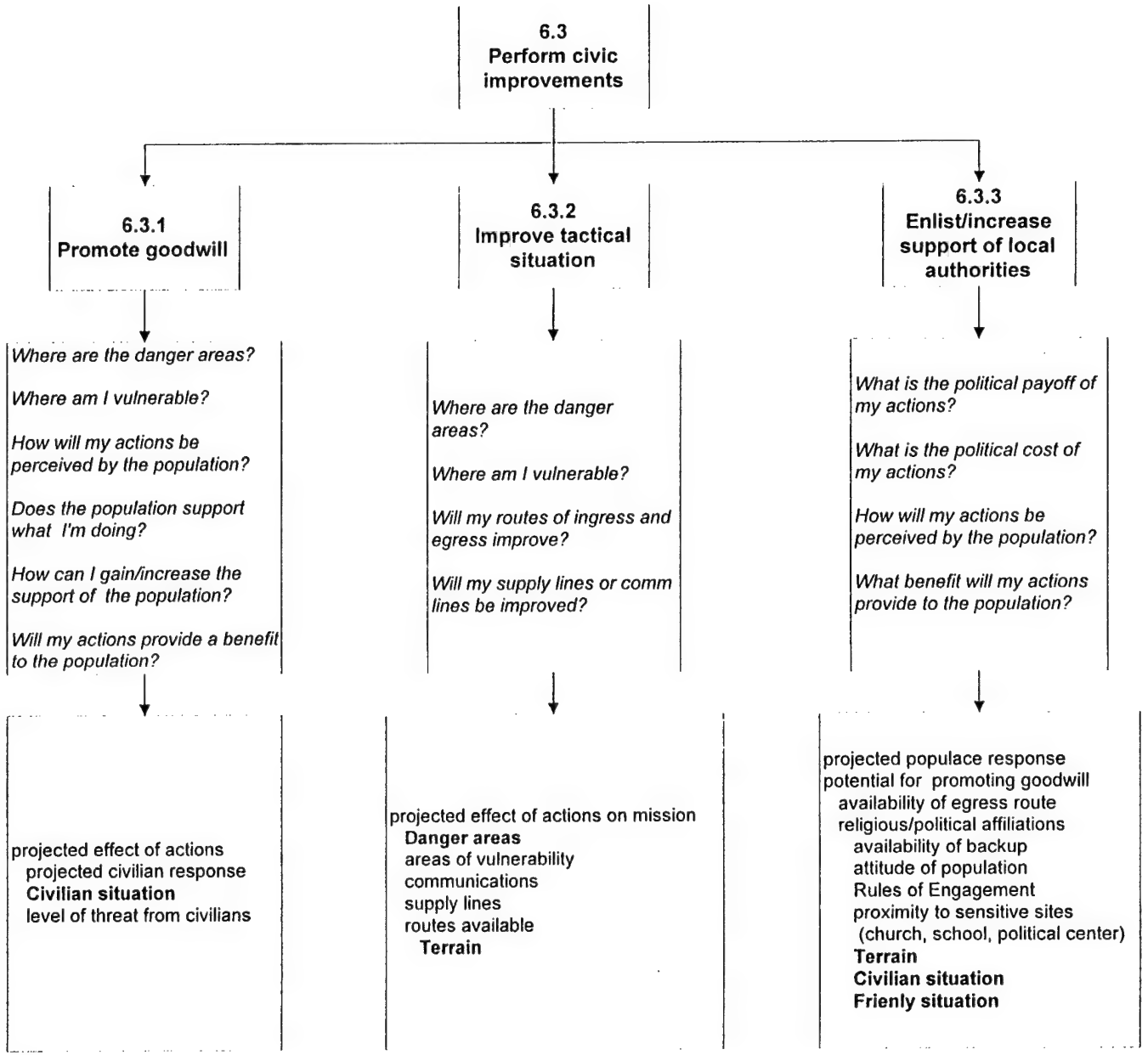

4.1
Plan/modify plan to accomplish mission
4.1.1
Develop COA
4.1.2
Continually re-evaluate plan
4.1.3
Distribute assets
4.1.4
Establish control measures
What are the feasible COAs?
What COA minimizes friendly risk and still accomplishes the mission?
How can we disrupt or minimize enemy strengths?
Are my routes still available?
Is my plan still viable?
What have I learned that necessitates changing the plan?
Can I relay change of plans to troops?
Will changing plans cause an unacceptable level of confusion ?
Are additional assets needed?
Where are assets needed?
Are assets available?
What strategic points should my troops move around?
What is the line of sight /FOF from each point?
projected effect of mission plan
assigned mission plans
Commander's Intent
Enemy strengths vs. weaknesses
Project enemy behavior(1.1.1)
Enemy threat
own strengths vs. weaknesses
Friendly situation
Terrain
Own plan of action (4.1.1)
communications status
unexpected circumstances
squads' progress in completing tasks
rooms secured
enemy resistance encountered
Enemy threat
Availability of alternate plans (4.1.1)
booby traps
casualties/evacuation needed
Friendly situation
Distribute assets (4.1.3)
asset availability
location
type
usage
time to obtain
ability to move assets
Enemy threat
need for assets
Squad tasks (1.3.3)
strategic points
Own plan of action (4.1.1)
projected field of observation
Terrain
projected field of fire
Terrain

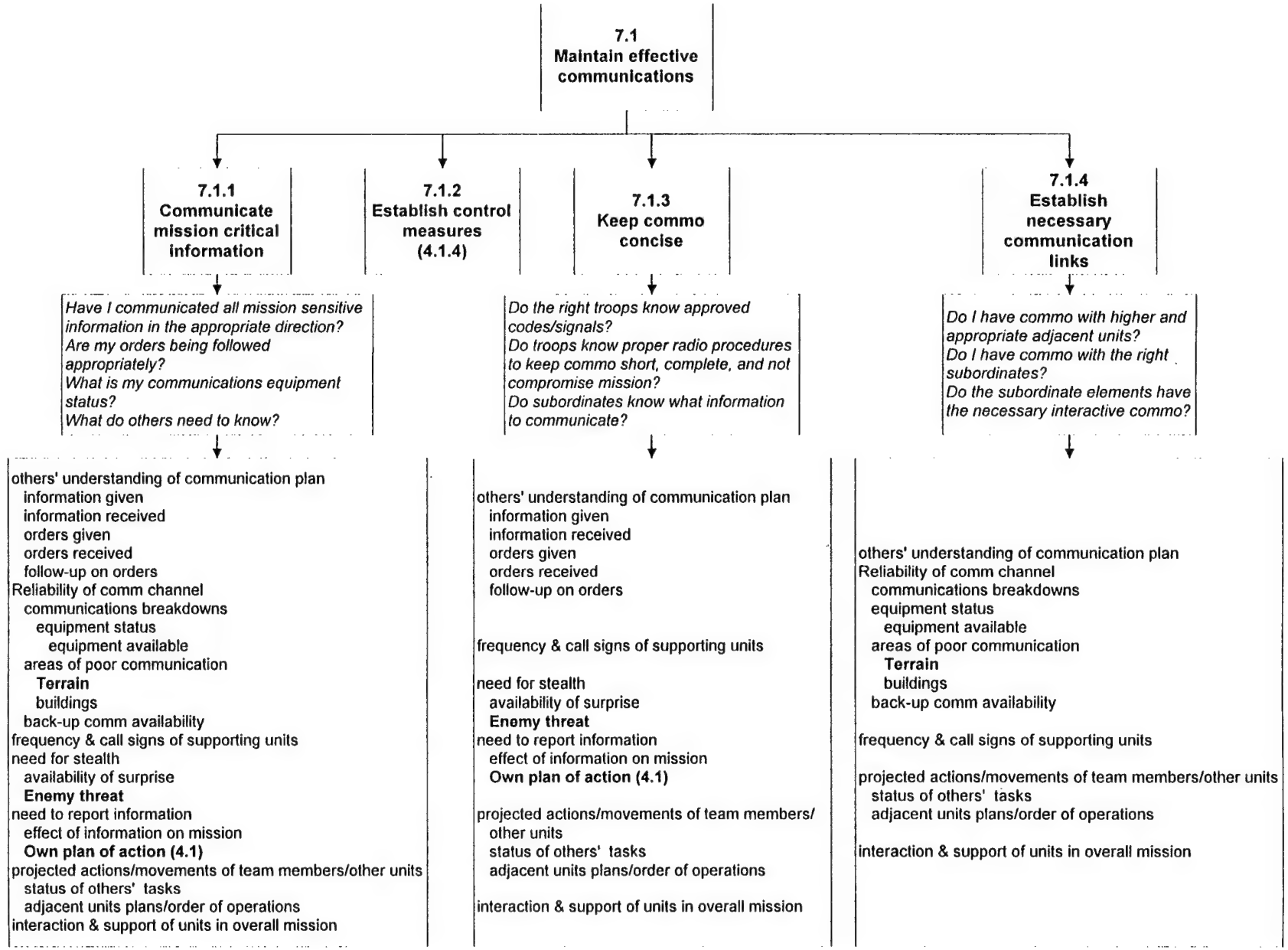

4.2
Consolidate/
Reorganize
4.2.1
Determine whether to continue mission
4.2.2
Treat & remove casualties and prisoners
4.2.3
Establish & maintain security (1.5)
4.2.4
Reallocate assets
Have I accomplished my mission objectives?
Have I defeated the threat?
Are my forces adequate to continue the mission?
Is there a safe route of egress to remove casualties & prisoners?
Can casualties be safely treated where they are?
Can caualties be adequately treated where they are?
Are there critical leadership positions that must be filled due to casualties?
Are key weapons manned?
Is mission-sensitive equipment functioning properly?
What is the status of our supply lines?
Can we repel expected enemy counterattack?
Who needs what?
ability to continue assault
need to continue assault
mission objectives accomplished
squads' tasks completed
enemy resistance remaining
Enemy threat
booby traps
combat power remaining
Friendly situation
assets remaining
projected danger areas
estimated time required for evacuation
projected safety of egress route
areas of cover
areas of concealment
Terrain
Enemy threat
Project enemy behavior(1.1.1)
projected effects of moving casualties
number of casualties
severity of casualties
medical personnel available
capabilities
medical equipment/supplies
Project enemy behavior (1.1.1)
expected enemy reinforcements
expected enemy commitment to regain
Determine squad/soldier assignments (1.3.3)
fill leadership positions
man key weapons
casualties
Maintain adequate ammo and supplies (1.2.2)
equipment status
supply status
supplies available
supply route functioning
time to resupply
ammo distribution
water distribution

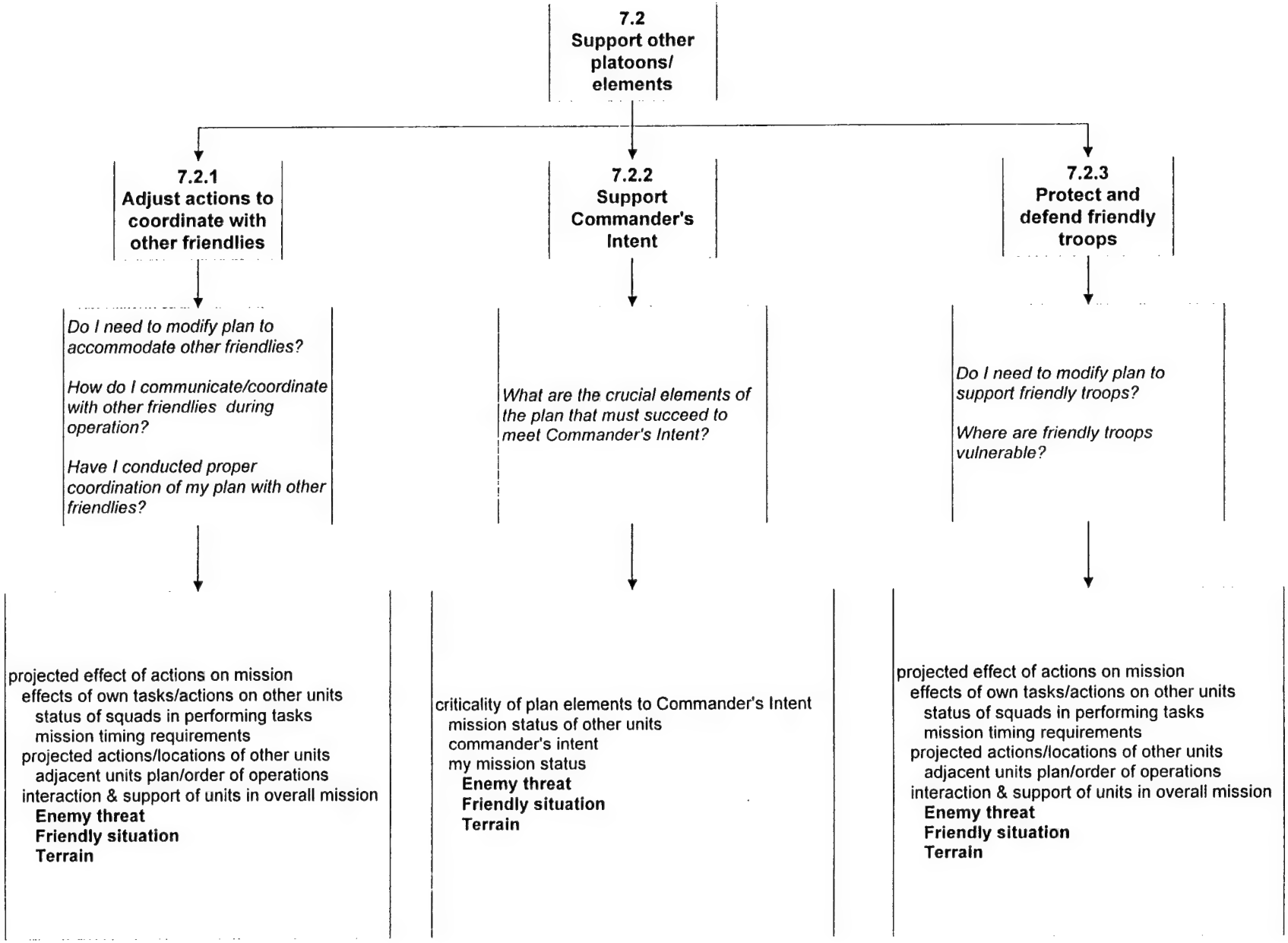

5.1
Prepare for enemy counterattack
5.1.1
Establish and maintain security (1.5)
5.1.2
Determine squad/soldier assignments (1.3.3)
5.1.3
Change enemy behavior (2.4)
5.1.4
Assign sectors of fire and concentration of fires
5.1.5
Project enemy behavior (1.1.1)
Where should fires be directed?
projected enemy breach point
likely avenue of enemy approach
Project enemy behavior (1.1.1)
areas of cover
areas of concealment
exposure areas
Terrain
Friendly situation


6.1
Establish and maintain order
6.1.1
Defuse dangerous situations
6.1.2
Establish mobile presence
6.1.3
Control collateral damage
How do I exert a presence?
How can I clear the area with minimal use of force?
Can I identify friendly, hostile and neutral civilians?
Who are the agitators?
Where should presence be exerted to achieve the desired result?
How will the populace react to my presence?
What is the source of the disturbance?
Are reinforcements needed?
What is the minimal force necessary to prevent further damage?
projected effect of actions
level of threat from civilians
expected danger areas
Project enemy response (1.1.1)
potential for escalation
potential for promoting goodwill
availability of egress route
availability of reinforcements
Enemy threat
Friendly situation
Terrain
Civilian Situation
projected effect of actions
level of threat from civilians
expected danger areas
Project enemy response (1.1.1)
potential for escalation
potential for promoting goodwill
availability of egress route
availability of reinforcements
Enemy threat
Friendly situation
Terrain
Civilian Situation
projected effect of actions
level of threat from civilians
expected danger areas
Project enemy response (1.1.1)
projected civilian response
projected civilian behavior
potential for escalation
potential for promoting goodwill
availability of egress route
Enemy threat
Friendly situation
Terrain
Civilian Situation
areas of damage
severity of damage
availability of reinforcements
availability of non-lethal assets


6.2
Protect/defend
civilians
6.2.1
Identify and
remove
agitators
6.2.2
Defuse dangerous
situations
(6.1.1)
6.2.3
Control collateral
damage
(6.1.3)
Who are the agitators?
How can I remove agitators
using minimal force?
Do I need reinforcements?
projected effects of actions
potential for escalation
projected civilian response
Civilian situation
level of threat from civilians
sensitive areas
availability of egress route
Enemy threat
Friendly situation
Terrain
availability of reinforcements
availability of non-lethal assets


6.3
Perform civic improvements
6.3.1
Promote goodwill
6.3.2
Improve tactical situation
6.3.3
Enlist/increase support of local authorities
Where are the danger areas?
Where am I vulnerable?
How will my actions be perceived by the population?
Does the population support what I'm doing?
How can I gain/increase the support of the population?
Will my actions provide a benefit to the population?
Where are the danger areas?
Where am I vulnerable?
Will my routes of ingress and egress improve?
Will my supply lines or comm lines be improved?
What is the political payoff of my actions?
What is the political cost of my actions?
How will my actions be perceived by the population?
What benefit will my actions provide to the population?
projected effect of actions
projected civilian response
Civilian situation
level of threat from civilians
projected effect of actions on mission
Danger areas
areas of vulnerability
communications
supply lines
routes available
Terrain
projected populace response
potential for promoting goodwill
availability of egress route
religious/political affiliations
availability of backup
attitude of population
Rules of Engagement
proximity to sensitive sites
(church, school, political center)
Terrain
Civilian situation
Frienly situation


7.1
Maintain effective communications
7.1.1
Communicate mission critical information
7.1.2
Establish control measures (4.1.4)
7.1.3
Keep commo concise
7.1.4
Establish necessary communication links
Have I communicated all mission sensitive information in the appropriate direction?
Are my orders being followed appropriately?
What is my communications equipment status?
What do others need to know?
Do the right troops know approved codes/signals?
Do troops know proper radio procedures to keep commo short, complete, and not compromise mission?
Do subordinates know what information to communicate?
Do I have commo with higher and appropriate adjacent units?
Do I have commo with the right subordinates?
Do the subordinate elements have the necessary interactive commo?
others' understanding of communication plan
information given
information received
orders given
orders received
follow-up on orders
Reliability of comm channel
communications breakdowns
equipment status
equipment available
areas of poor communication
Terrain
buildings
back-up comm availability
frequency & call signs of supporting units
need for stealth
availability of surprise
Enemy threat
need to report information
effect of information on mission
Own plan of action (4.1)
projected actions/movements of team members/other units
status of others' tasks
adjacent units plans/order of operations
interaction & support of units in overall mission
others' understanding of communication plan
information given
information received
orders given
orders received
follow-up on orders
frequency & call signs of supporting units
need for stealth
availability of surprise
Enemy threat
need to report information
effect of information on mission
Own plan of action (4.1)
projected actions/movements of team members/ other units
status of others' tasks
adjacent units plans/order of operations
interaction & support of units in overall mission
others' understanding of communication plan
Reliability of comm channel
communications breakdowns
equipment status
equipment available
areas of poor communication
Terrain
buildings
back-up comm availability
frequency & call signs of supporting units
projected actions/movements of team members/other units
status of others' tasks
adjacent units plans/order of operations
interaction & support of units in overall mission


7.2
Support other platoons/ elements
7.2.1
Adjust actions to coordinate with other friendlies
7.2.2
Support Commander's Intent
7.2.3
Protect and defend friendly troops
Do I need to modify plan to accommodate other friendlies?
How do I communicate/coordinate with other friendlies during operation?
Have I conducted proper coordination of my plan with other friendlies?
What are the crucial elements of the plan that must succeed to meet Commander's Intent?
Do I need to modify plan to support friendly troops?
Where are friendly troops vulnerable?
projected effect of actions on mission
effects of own tasks/actions on other units
status of squads in performing tasks
mission timing requirements
projected actions/locations of other units
adjacent units plan/order of operations
interaction & support of units in overall mission
Enemy threat
Friendly situation
Terrain
criticality of plan elements to Commander's Intent
mission status of other units
commander's intent
my mission status
Enemy threat
Friendly situation
Terrain
projected effect of actions on mission
effects of own tasks/actions on other units
status of squads in performing tasks
mission timing requirements
projected actions/locations of other units
adjacent units plan/order of operations
interaction & support of units in overall mission
Enemy threat
Friendly situation
Terrain

Situation Awareness Categories for Platoon Leaders in MOUT

ENEMY THREAT

- Anticipated enemy actions
  - enemy intent
  - enemy objective
- enemy composition
  - unit type
  - equipment
  - experience level
  - morale/commitment
  - vehicle
  - capabilities/skills/training
  - recent actions
- enemy patterns of movement
  - locations of ammo/supplies
  - movement of weapons
  - security/patrol formations & schedule
  - enemy center of gravity
- enemy disposition
  - location
  - dispersion
  - numbers
  - weapons
  - ammo/supplies
  - objective
- enemy psychology
  - enemy doctrine
  - past behavior/actions
  - religious/political beliefs
- enemy field of observation
- enemy field of fire
  - building vantage points
    - windows
    - doorways
    - rooftops
  - funnel areas

CIVILIAN SITUATION

- projected civilian behavior
  - location
  - number
  - level of organization
  - mood of crowd
  - religious/political beliefs
  - agitators present
  - threatening actions
  - weapons
  - morale/commitment
  - training/skills
  - intent
- Rules of Engagement

FRIENDLY SITUATION

- Anticipated friendly actions
  - Commander's Intent
  - unit objective
- friendly composition
  - unit type
  - equipment
  - experience level
  - morale/commitment
  - vehicle
  - capabilities/skills/training
  - fatigue/soldier load
- troop disposition
  - location
  - dispersion
  - numbers
  - weapons
  - ammo/supplies
- troop psychology
  - troop doctrine
  - past behavior/actions
  - religious/political beliefs
- friendly field of observation
- friendly field of fire
  - building vantage points
    - windows
    - doorways
    - rooftops
  - funnel areas

TERRAIN

- Type of terrain
  - hilly
  - flat
  - mountainous
  - urban
- conditions
  - rubble
  - mud
- day/night
- features
  - vegetation
  - obstacles
  - buildings
    - usage
    - construction
      - mass construction
      - framed construction
        - heavy clad
        - light clad
        - open
    - entry points
    - vantage points

WEATHER CONDITIONS

- temperature
- precipitation
- wind
- visibility
- ambient noise

DANGER AREAS

- roads
- streams
- open areas
- railroad tracks
- corridors
- stairwells
- windows
- doorways
- funnel areas

Descriptives

NEWRANK = enlisted

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	445	18.00	37.00	22.0899	3.1481
Valid N (listwise)	445				

a. NEWRANK = enlisted

NEWRANK = NCO

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	193	20.00	49.00	30.3523	5.5284
Valid N (listwise)	193				

a. NEWRANK = NCO

NEWRANK = officer

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	46	22.00	40.00	28.5435	4.6462
Valid N (listwise)	46				

a. NEWRANK = officer

Appendix B: SAGAT Instructions to Platoon Leaders

SAGAT INSTRUCTIONS T0 SUBJECTS

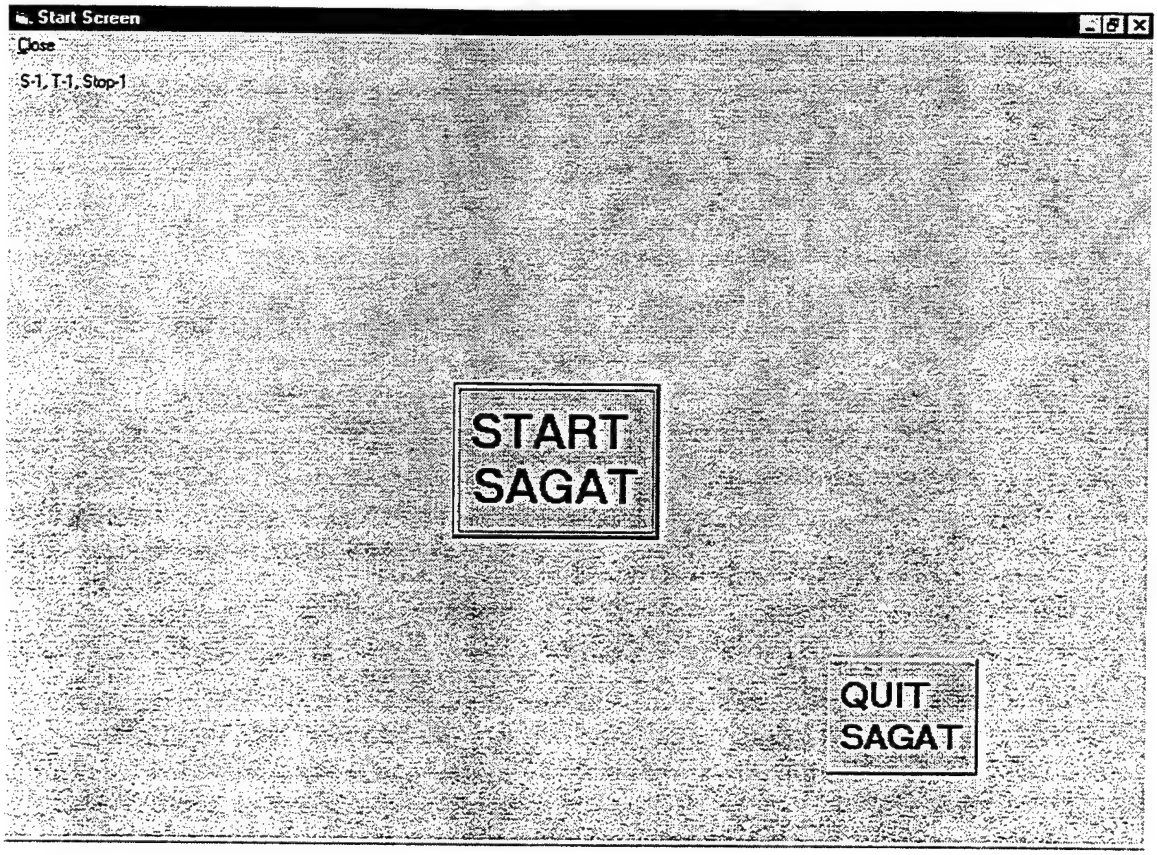
Situation awareness (SA) is critical to directing and executing Infantry operations. For the purpose of this test, situation awareness is formally defined as: *the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.* This means your perception of what is happening in the situation, including friendly, enemy, neutral, and non-combatant disposition, actions and intentions, and what that all means to you as a platoon leader.

The Situation Awareness Global Assessment Technique (SAGAT) has been developed to objectively measure situation awareness (SA) in manned simulations.

- During the trial, the simulation will be frozen at randomly determined intervals and the visual scene blanked.
- You will be asked about your knowledge of specific SA components, as you perceive them, at that point in time.
- The questions will be presented on a PC. The questions have been created to allow for quick and easy data input using the cursor.
- You will not be allowed to talk to anyone other than the Test Director when completing the questions.
- The questions should be answered as rapidly as possible.
- Even if you do not know some of the information exactly, you should make your best guess. There is no penalty for guessing. If you really have no idea at all of the answer to a question, you may simply click on the "done" box on the screen to go on to the next question. You are generally better off making your best guess, however.
- Following the SAGAT session you will resume the trial exactly where you left off. You will turn around and when ready the simulation will be resumed.

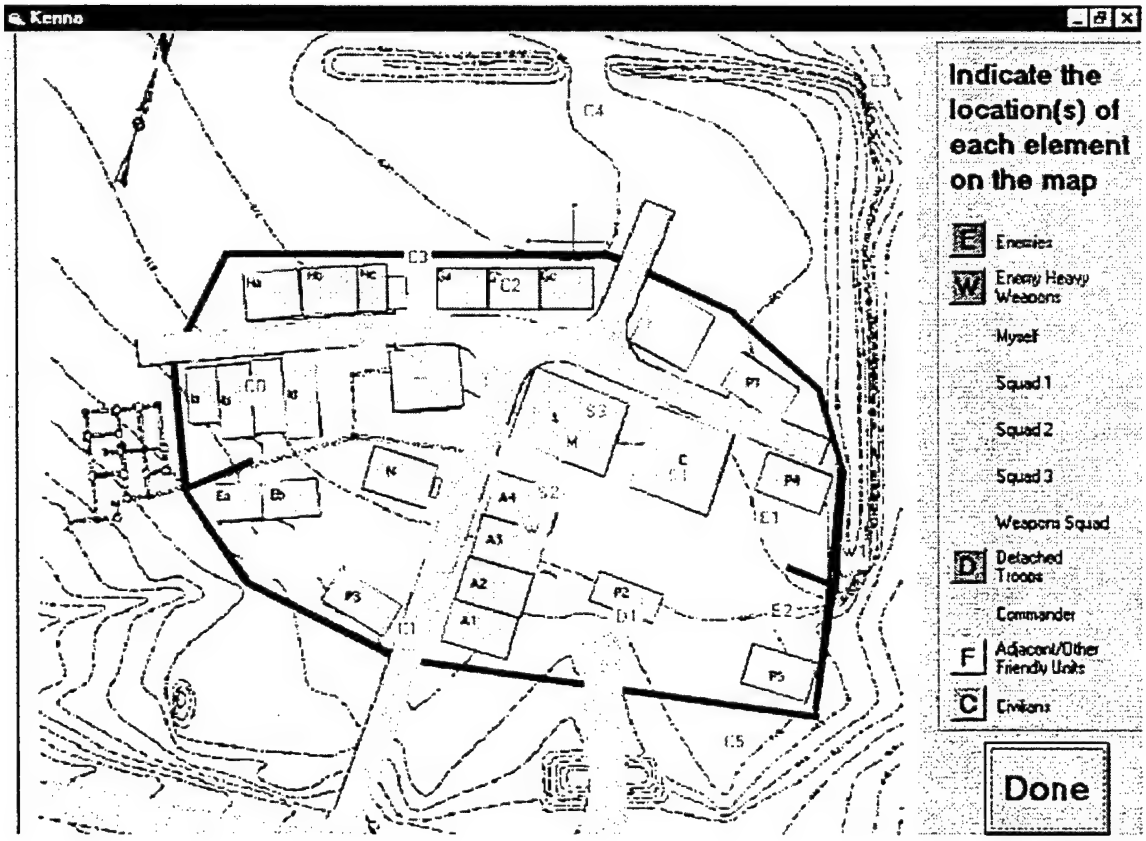
The purpose of SAGAT is to evaluate systems and training concepts, not to evaluate you as an individual. You may not be able to answer many of the questions you will be asked. Don't worry about this, as the questions are intended to assess ideal SA. Some of this information may not be available or may not be adequately accurate.

You will have the opportunity to practice answering the SAGAT questions before testing begins. Please direct any questions you may have to the Test Director.



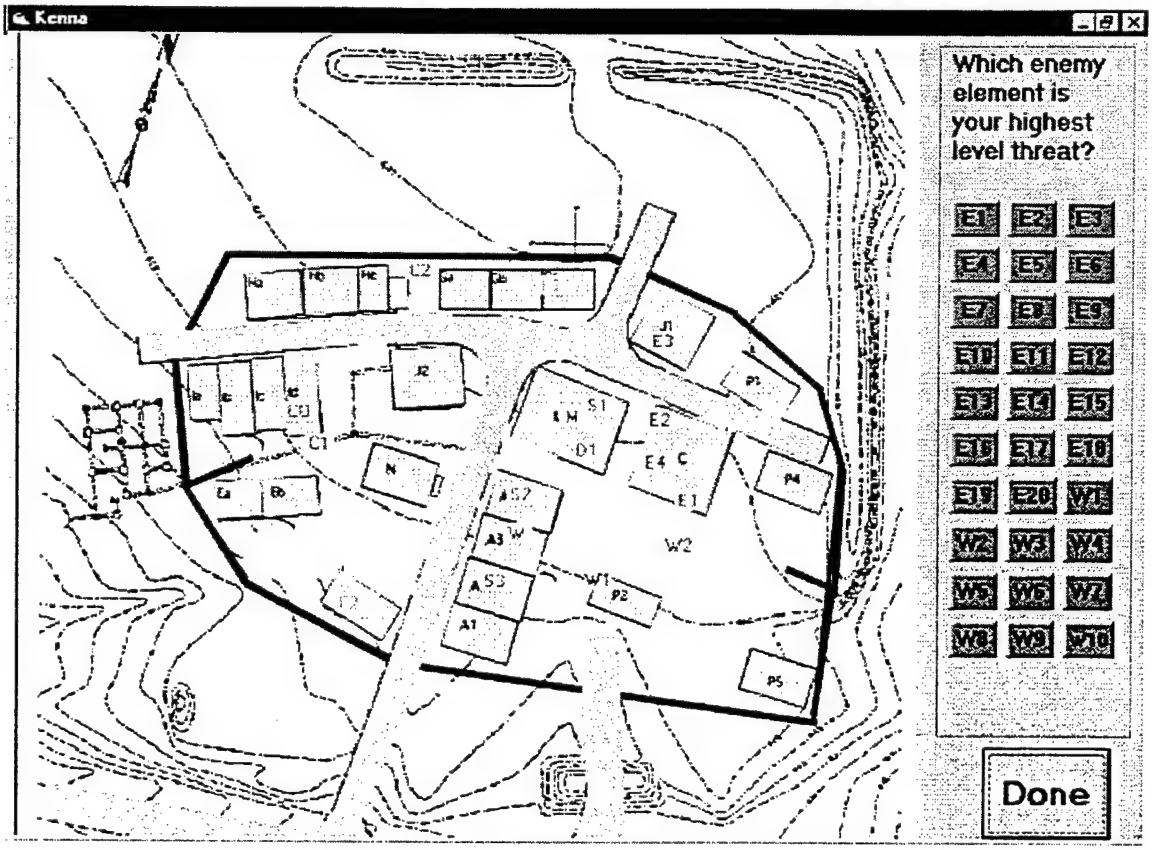
To begin the program click on the button marked "START SAGAT".

1



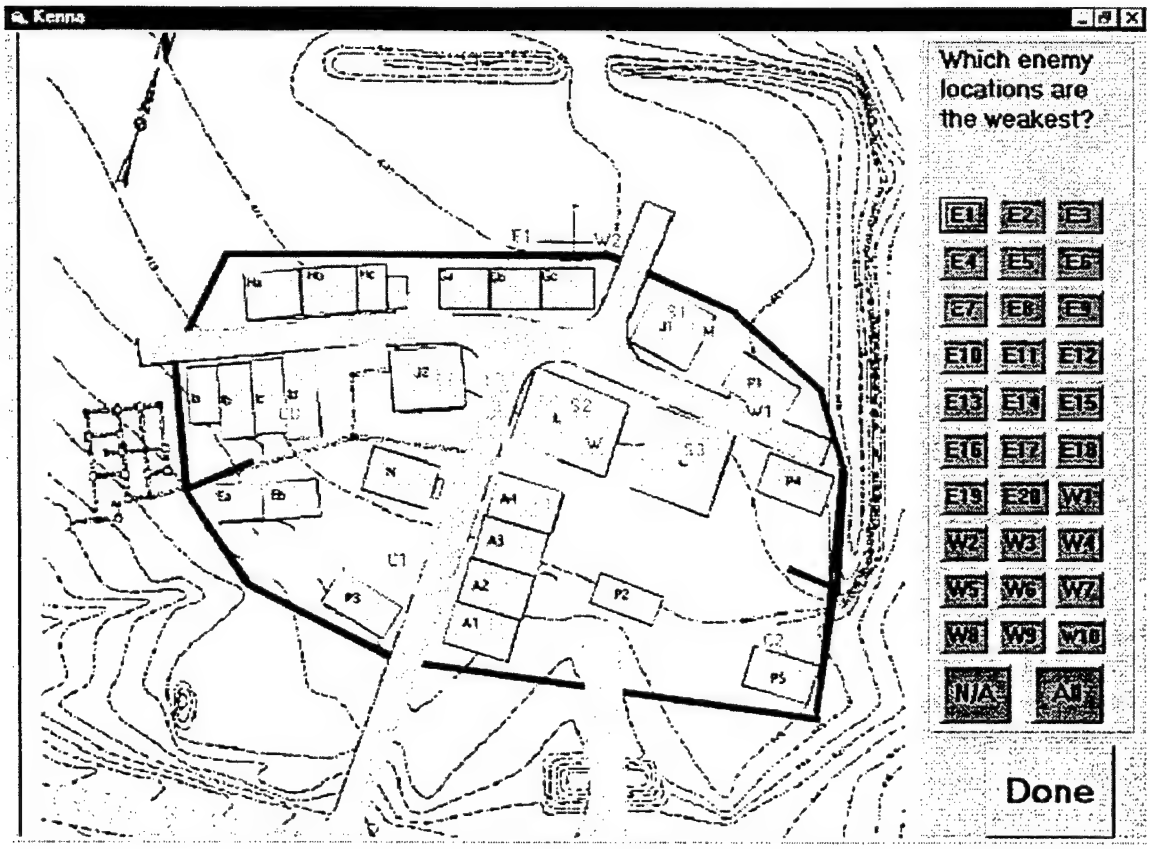
Click on the symbol next to each element that is currently alive and present in the battlefield and drag it to its current location. (You may move the symbols on the map if they are not placed correctly). Indicate the location of yourself, your commander, the main squad locations (with their squad leader), weapons squad location and any teams that have become detached from their main squads and are located separately. In addition indicate the location of any known enemies, enemy heavy weapons locations, other friendly units (outside of your platoon) and civilians. Click on the Done button when you are finished indicating the location of all known parties.

2



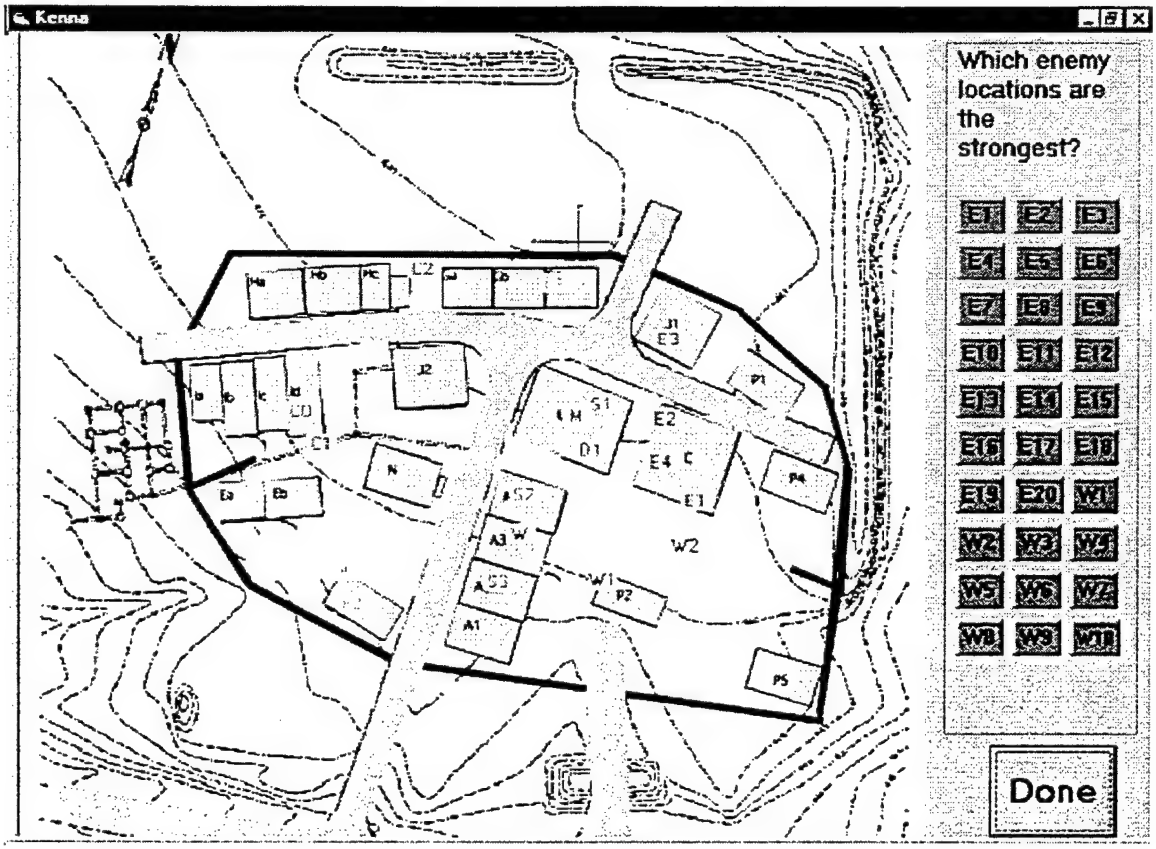
The location of all the elements you indicated in the first question are presented on the left. Click on the button that corresponds to the enemy unit that is the highest level threat to your platoon at this time. Click on the Done button when you are finished.

4



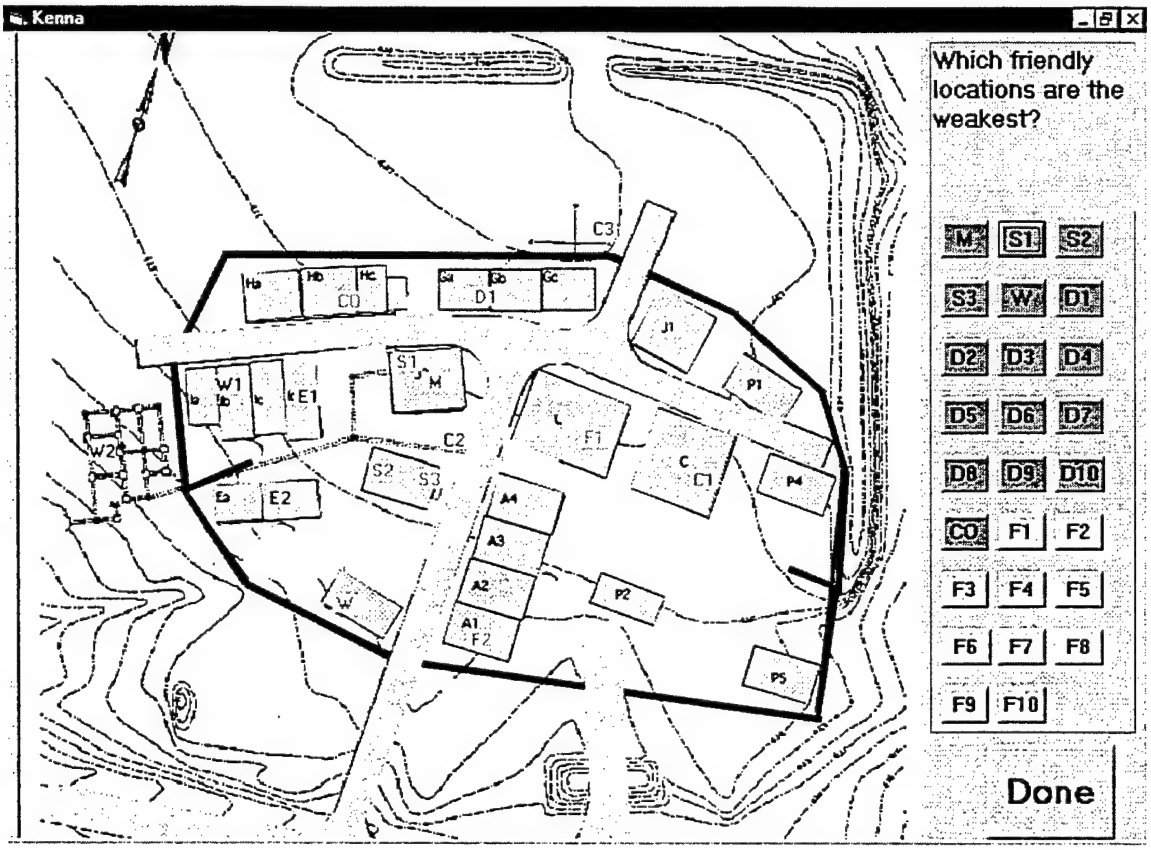
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

5



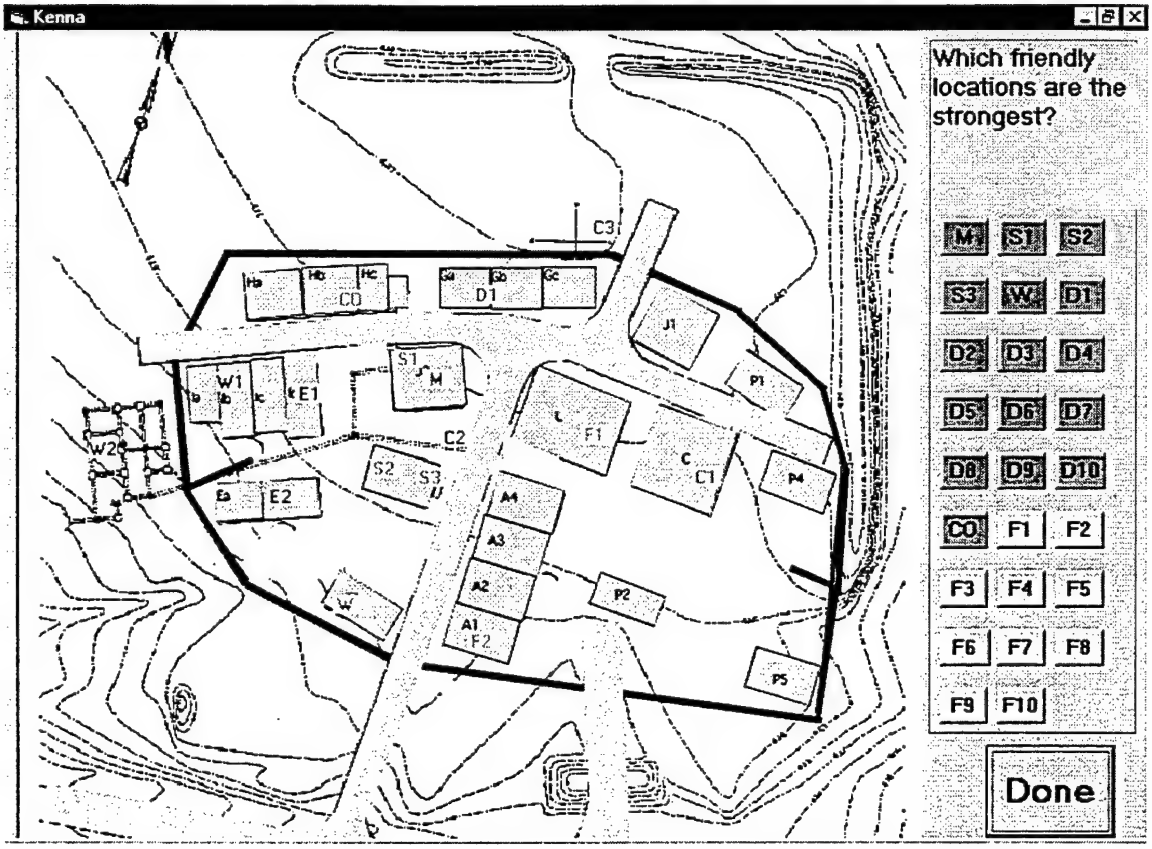
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

6



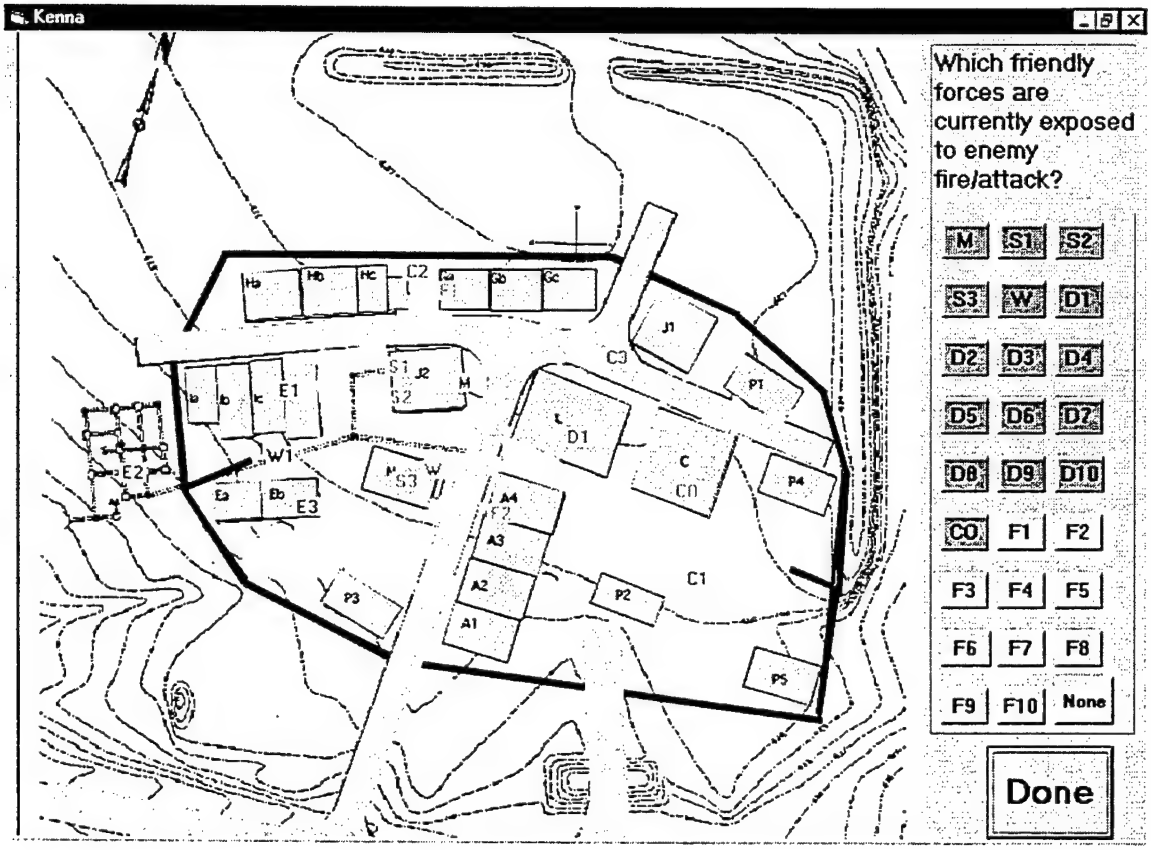
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

7



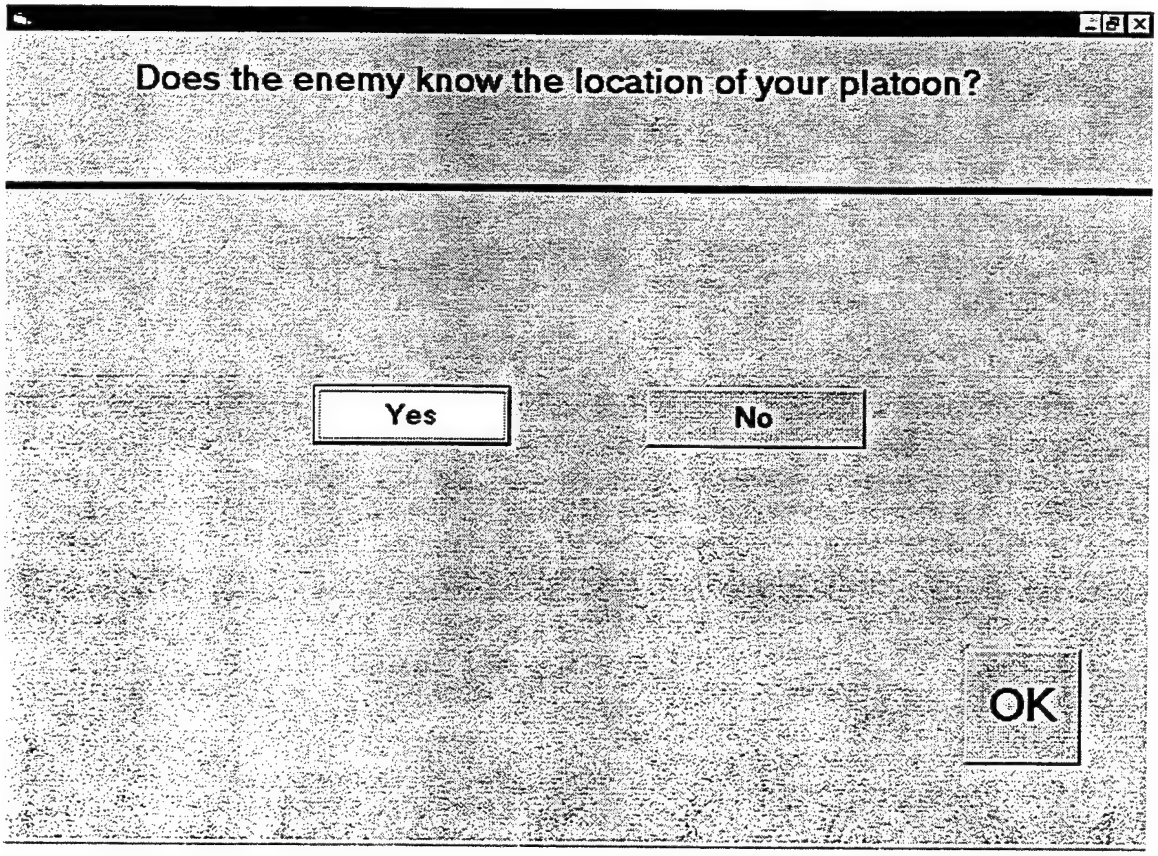
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

9



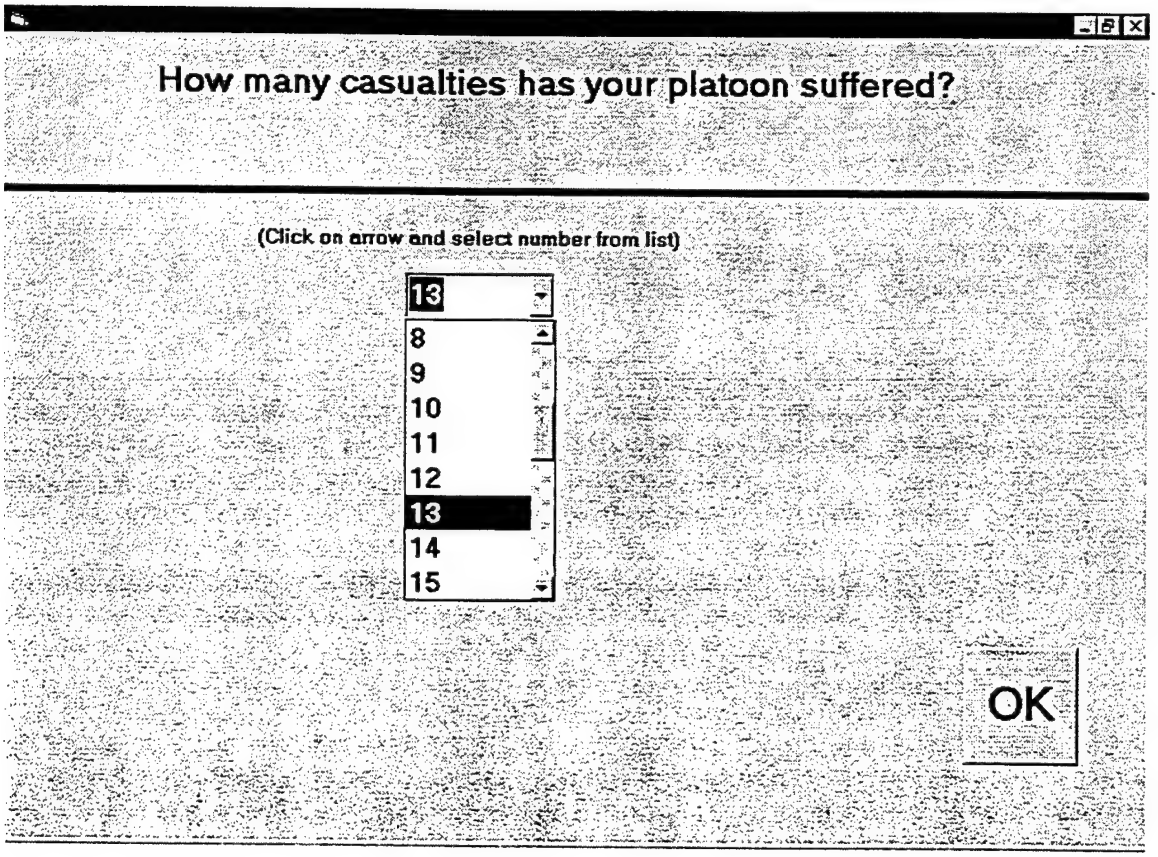
The locations of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units who are currently exposed to enemy fire/attack. You may indicate more than one. Click on the Done button when finished.

12



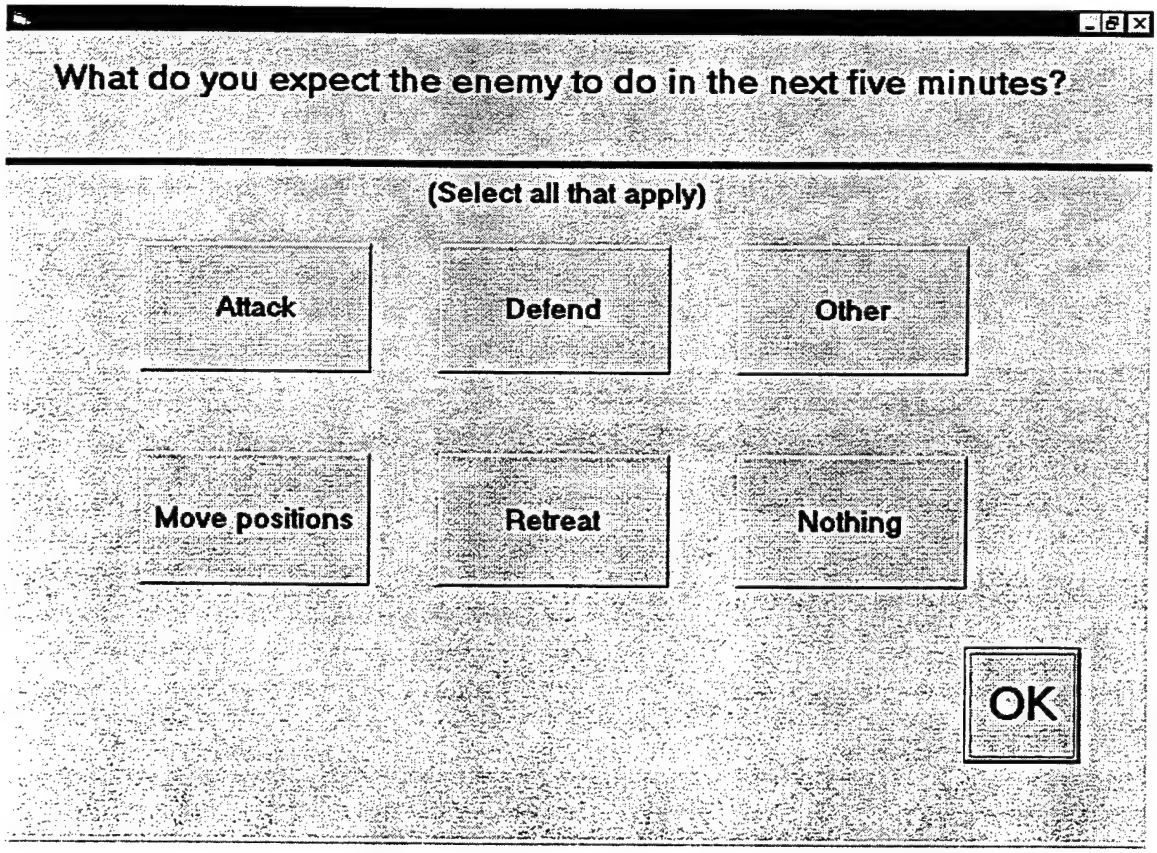
Indicate whether any enemy troops currently are aware of your location or that of any of your platoon. Click on the OK button when you are done.

16



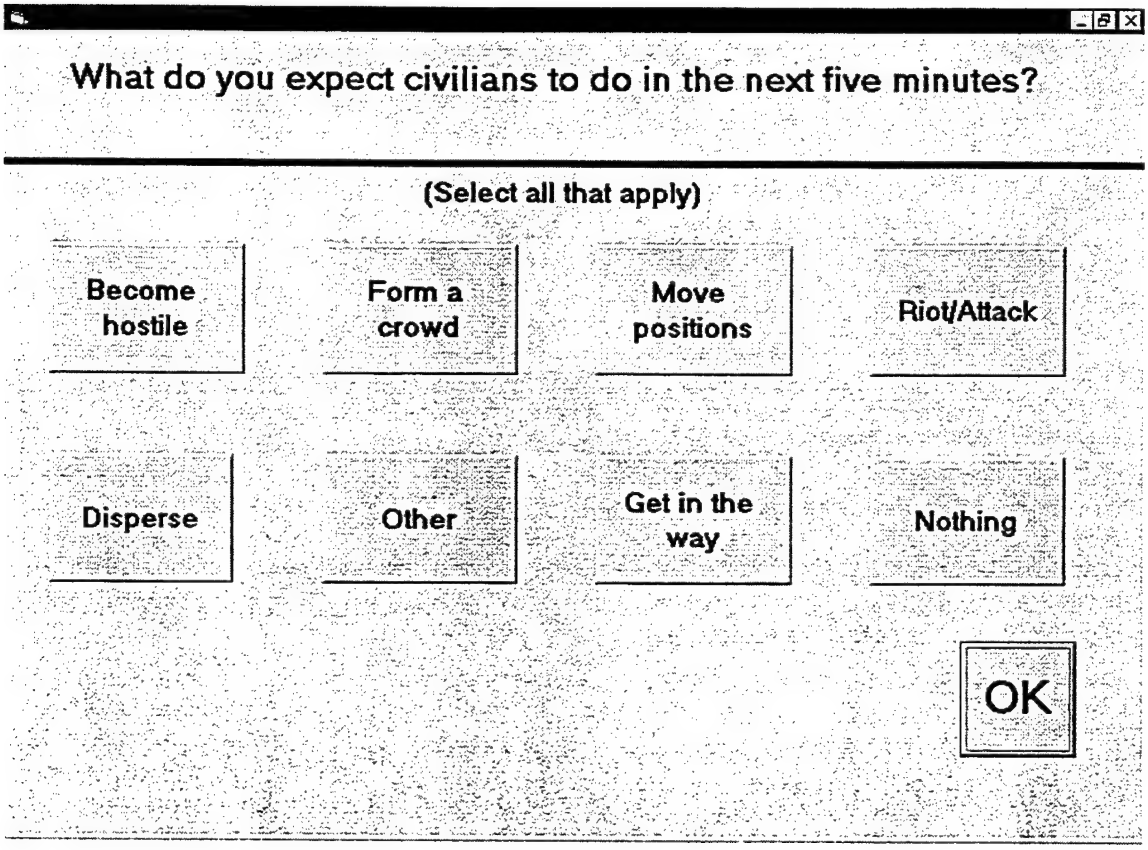
Indicate how many casualties your platoon has suffered up to this point by using the pull down menu. Click on the OK button when you are done.

17



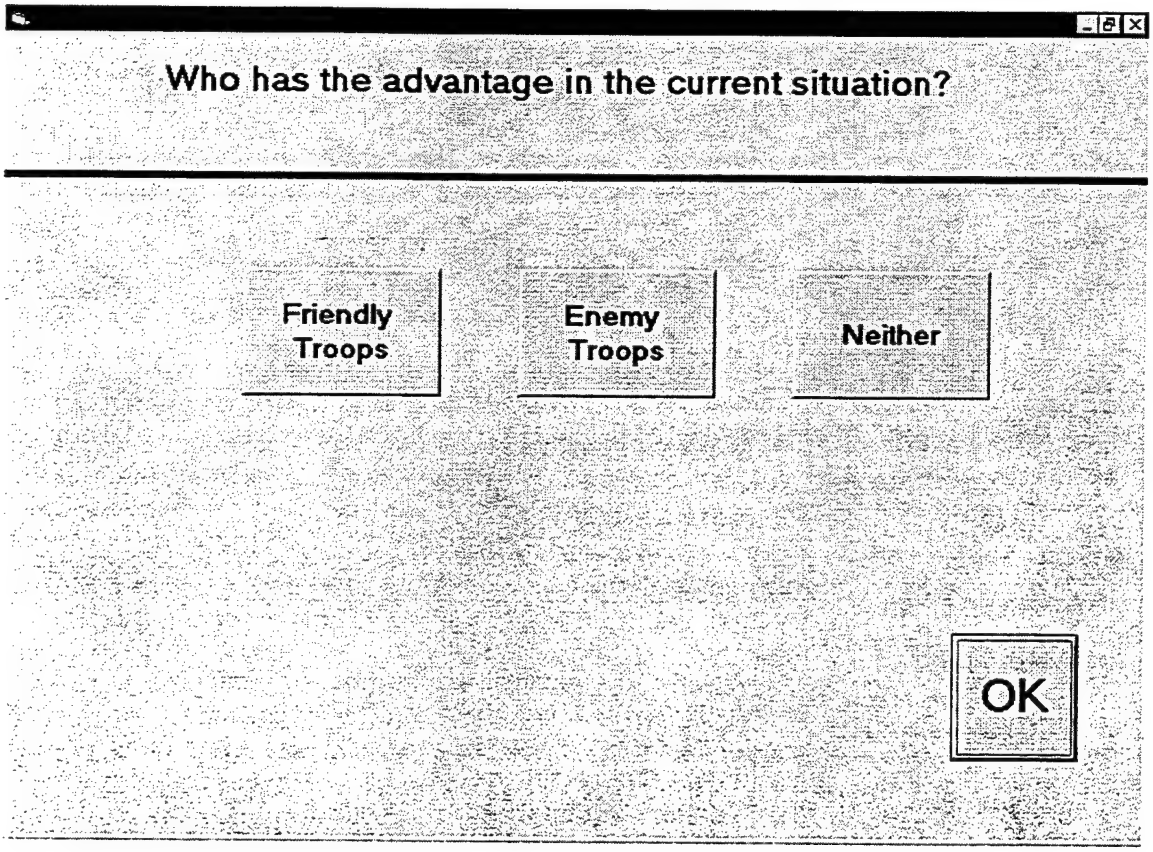
Indicate what actions you expect the enemy troops in this scenario to take in the next five minutes. Click on the OK button when you are done.

18



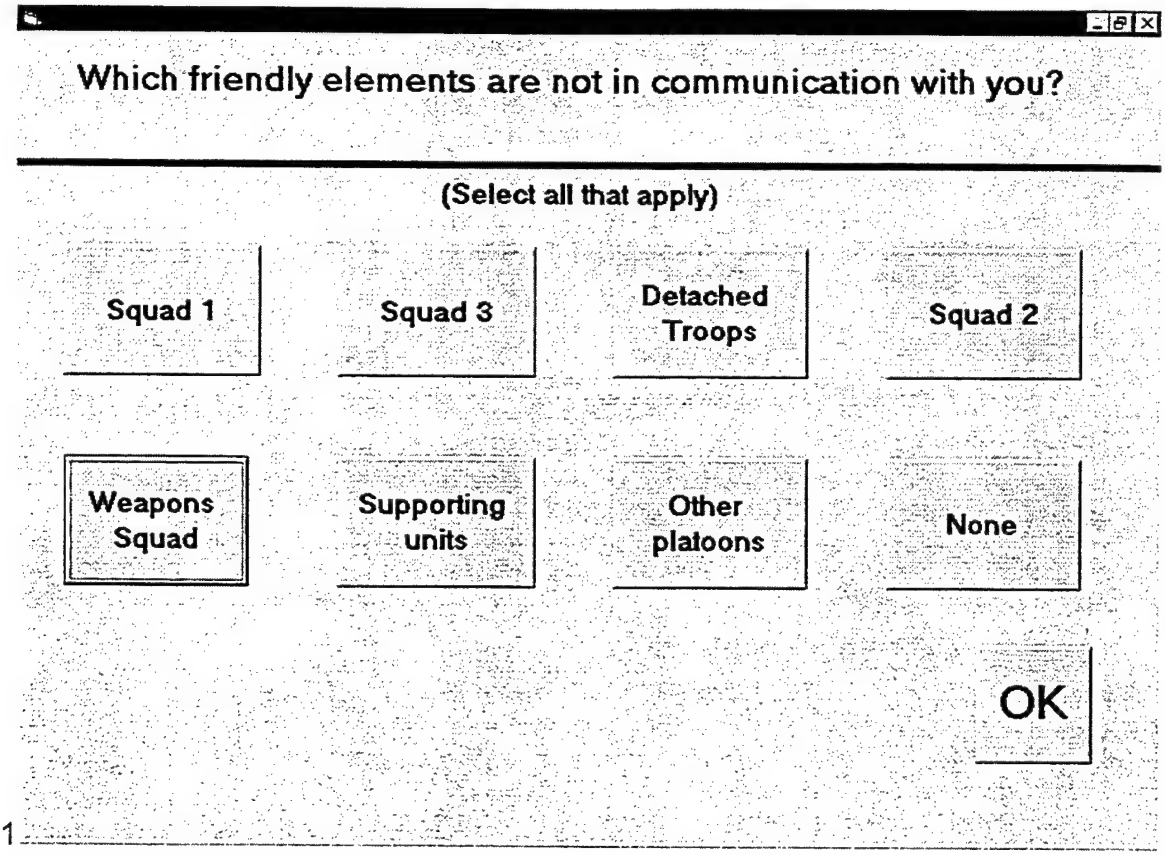
Indicate what actions you expect the civilians in this scenario to take in the next five minutes. Click on the OK button when you are done.

19



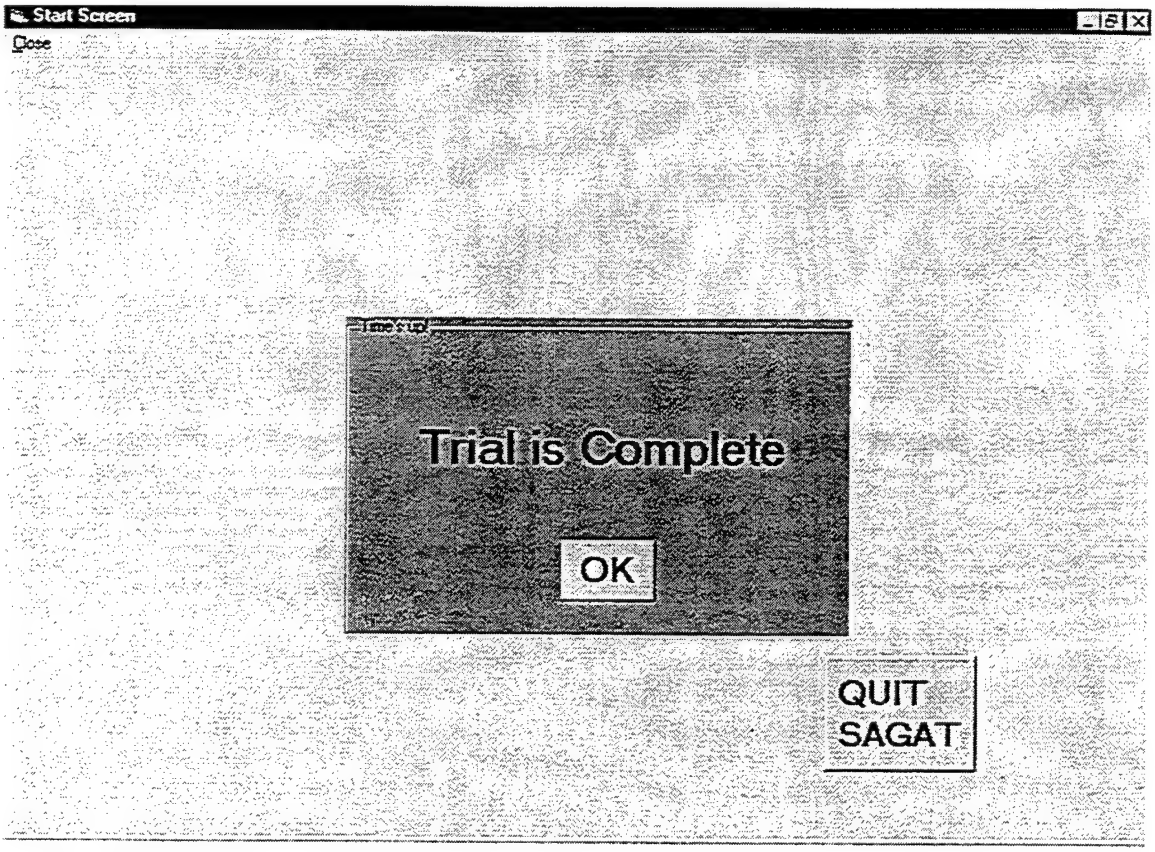
Indicate whether friendly or enemy troops (or neither) currently have the advantage by clicking on the appropriate button. Click on the OK button when you are done.

21



1

Indicate whether any of the above friendly troops have lost communications with you. If all are in communication with you, click on the None button. Click on the OK button when you are done.



When you see this screen, you are finished answering the SAGAT questions. You will return to the simulation trial, following input from the test director.

Appendix C: SABARS Instrument

Situation Awareness Behaviorally Anchored Rating Scale (SABARS)

Rating Items	*Very Poor*	*Poor*	*Borderline*	*Good*	*Very Good*	*Not Applicable*
1. Sets appropriate levels of alert	1	2	3	4	5	0
2. Solicits information from squad leaders	1	2	3	4	5	0
3. Solicits information from civilians (*)	1	2	3	4	5	0
4. Solicits information from commanders	1	2	3	4	5	0
5. Effects coordination with other platoon leaders (*)	1	2	3	4	5	0
6. Communicates key information to commander	1	2	3	4	5	0
7. Communicates key information to squad leaders	1	2	3	4	5	0
8. Communicates key information to other platoon leaders (*)	1	2	3	4	5	0
9. Monitors company net	1	2	3	4	5	0
10. Assesses information received	1	2	3	4	5	0
11. Asks for pertinent intelligence information	1	2	3	4	5	0
12. Employs squads tactically to gather needed information	1	2	3	4	5	0
13. Employs graphic or other control measures for squad execution (*)	1	2	3	4	5	0
14. Communicates to squads, situation and commander's intent	1	2	3	4	5	0
15. Utilizes a standard reporting procedure	1	2	3	4	5	0
16. Identifies critical mission tasks to squad leaders	1	2	3	4	5	0
17. Ensures avenues of approach are covered	1	2	3	4	5	0
18. Locates self at vantage point to observe main effort	1	2	3	4	5	0
19. Deploys troops to maintain platoon communications (*)	1	2	3	4	5	0
20. Uses assets to effectively assess environment	1	2	3	4	5	0
21. Performs a leader's recon to assess terrain and situation (*)	1	2	3	4	5	0
22. Identifies observation points, avenues of approach, key terrain, obstacles, cover and concealment	1	2	3	4	5	0
23. Assesses key finds and unusual events	1	2	3	4	5	0
24. Discerns key/critical information from maps, records, and supporting site information (*)	1	2	3	4	5	0
25. Discerns key/critical information from reports received	1	2	3	4	5	0
26. Projects future possibilities and creates contingency plans (*)	1	2	3	4	5	0
27. Gathers follow up information when needed	1	2	3	4	5	0
28. Overall Situation Awareness Rating	1	2	3	4	5	0

* Designates items not applicable in the present simulated missions

Appendix D: PSAQ Instrument

Post Trial Participant Subjective Questionnaire

1. Please circle the number below that best describes **how hard you were working** during this scenario.	not hard	1	2	3	4	5	extremely hard
Comments:							

2. Please circle the number that best describes **how well you performed** during this scenario	extremely poor	1	2	3	4	5	extremely well
Comments:							

3. Please circle the number that best describes **how aware of the evolving situation you were during the scenario.**	Not aware of situation	1	2	3	4	5	Completely aware of situation
Comments:							

Comments:

Appendix E: Biographical Information Questionnaire

Biographical Information Questionnaire

Name_____ Unit_____ Date_____

Please fill in the blank or mark or circle the appropriate response.

1. What is your age? _____ Years

2. MOS _____

3. Rank _____

4. Time in service Years _____ Months _____

5. What is the source of your commission?

   _____ROTC _____USMA _____OCS

6. What is your current (or most recent) duty position? _____
How long in this position? _____

7. What Army training courses have you completed? Check all that apply.

   _____ OSUT/AIT _____ PLDC _____BNCOC _____IOBC

   _____BFV Leader Course _____ Airborne _____ Ranger

   _____Air Assault _____Combat Life Saver Course

   _____Other (please specify)_____

8. How susceptible to motion or car sickness do you feel you are?

1	2	3	4	5	6	7
not susceptible			moderately susceptible			highly susceptible

9. Do you have normal or corrected to normal 20/20 vision? ____Yes ___No

10. Are you color blind? _____Yes _____No

11. Are you _____right handed? _____left handed?

12. My level of confidence in using computers is

1	2	3	4	5
low		average		high

13. How many hours per week do you use computers? _____ hours per week

14. How many times in the last year have you experienced a virtual reality game or entertainment?

0 1 2 3 4 5 6 7 8 9 10 11 12+

15. How often have you trained at the McKenna MOUT site (not including demos)?

_____ not since basic training _____1-3 times _____more than 3 times

16. Have you ever been in a Virtual Individual Combatant (VIC) simulator at the Land Warrior Test Bed before?

_____Yes _____No

If YES, which one(s)? (Describe if you cannot remember the name)

17. Have you had any <u>other</u> experience with military computer simulations?

_____Yes _____No

If yes, please describe briefly or give the names of the simulators.

Appendix F: Assault Scenario Flow Chart

Scenario B: Company Assault 2d PLT Mission from Building L to A4

1. Co A, 1-11th Infantry is conducting a company assault on the town of Kenna. The company is attacking the town from north to south. The initial assault was successful. The 1st Platoon attacked the H-series buildings and has successfully cleared BLDGs J2 and the I-series buildings. They are currently in the I-series building preparing to assault the E-series buildings. Their follow-on objectives are BLDGs N and P3. The 3d Platoon successfully attacked and cleared BLDGs P1, P4, and C. They are currently in BLDG C, preparing to attack BLDG P2. Their follow-on objective is BLDG P5.

2. The 2d Platoon, your platoon, is in the center. Your platoon has successfully cleared the G-series buildings and is currently located in BLDG L. You are at 100% strength. You are preparing to assault BLDGs A4 then A3, A2, and A1 respectively. The commander has directed you to observe the assault from a vantage point from the 2d floor of BLDG L. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3 line squads. There are no other attachments to the platoon.

3. The enemy is expected to provide stiff resistance as he withdraws his forces to follow-on positions to the southern part of town. The enemy is estimated at platoon strength. He has mortars, but has not yet employed them. He is fighting from well-fortified, prepared positions.

4. Ration cycle is C, C, T. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.

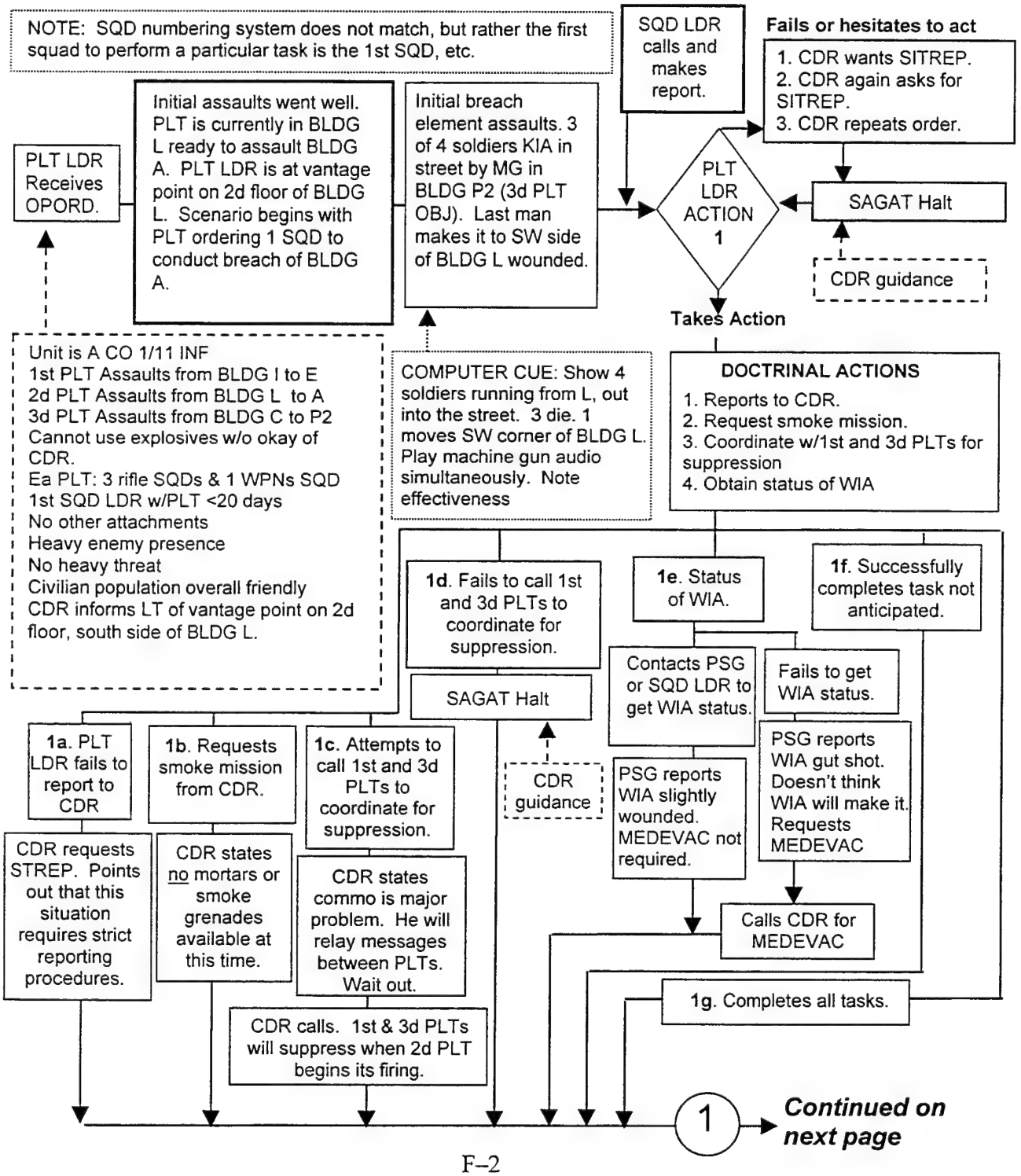
5. Rules of Engagement (ROE). Since the local civilian population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except against confirmed enemy locations. Targets must be clearly identified as hostile. Every effort must be made to avoid civilian casualties. Explosives cannot be used without permission of the company commander. Weapons control status is yellow.

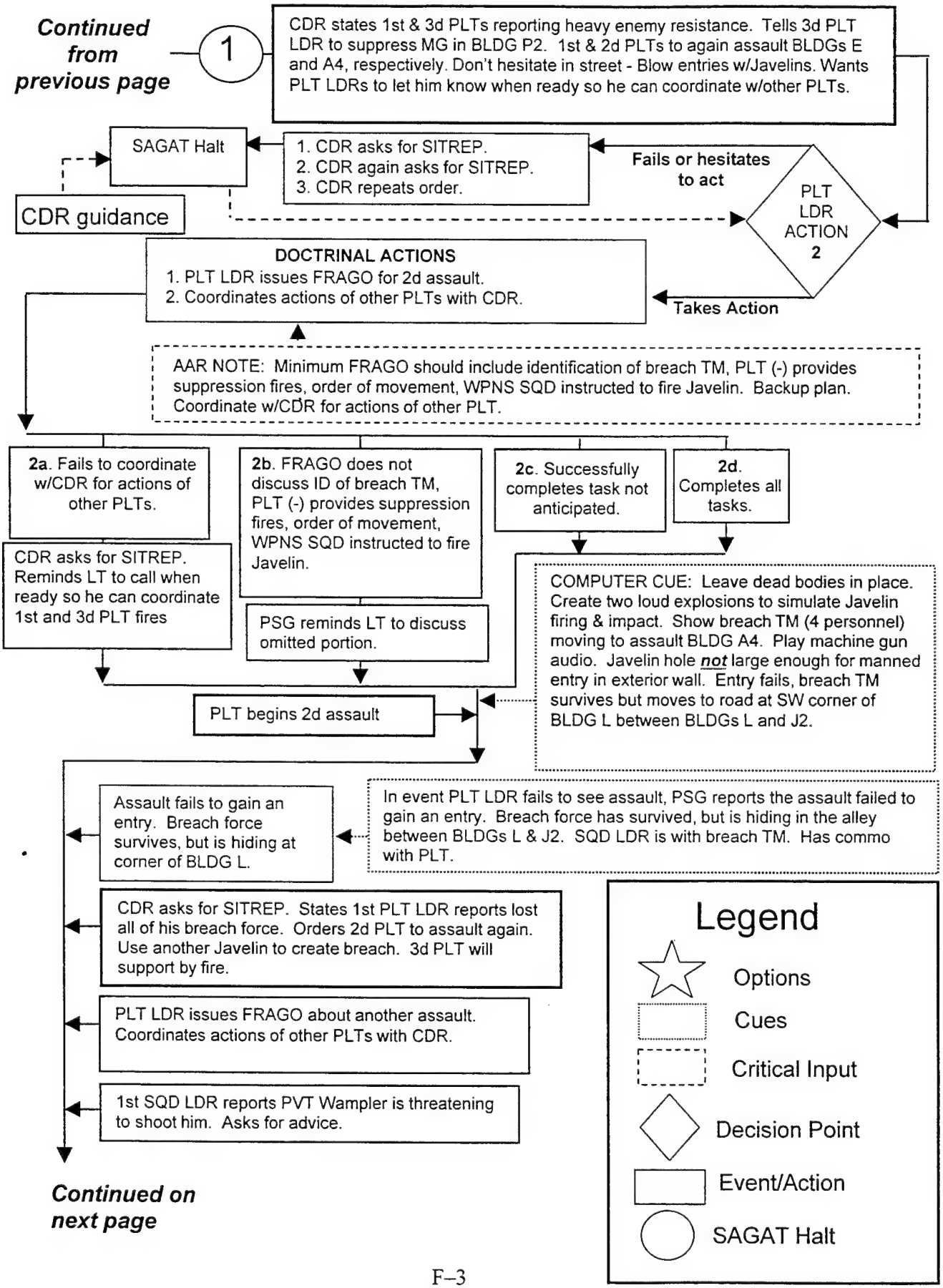
6. Your immediate task is to plan the assault on BLDG A4 and brief your squad leaders.

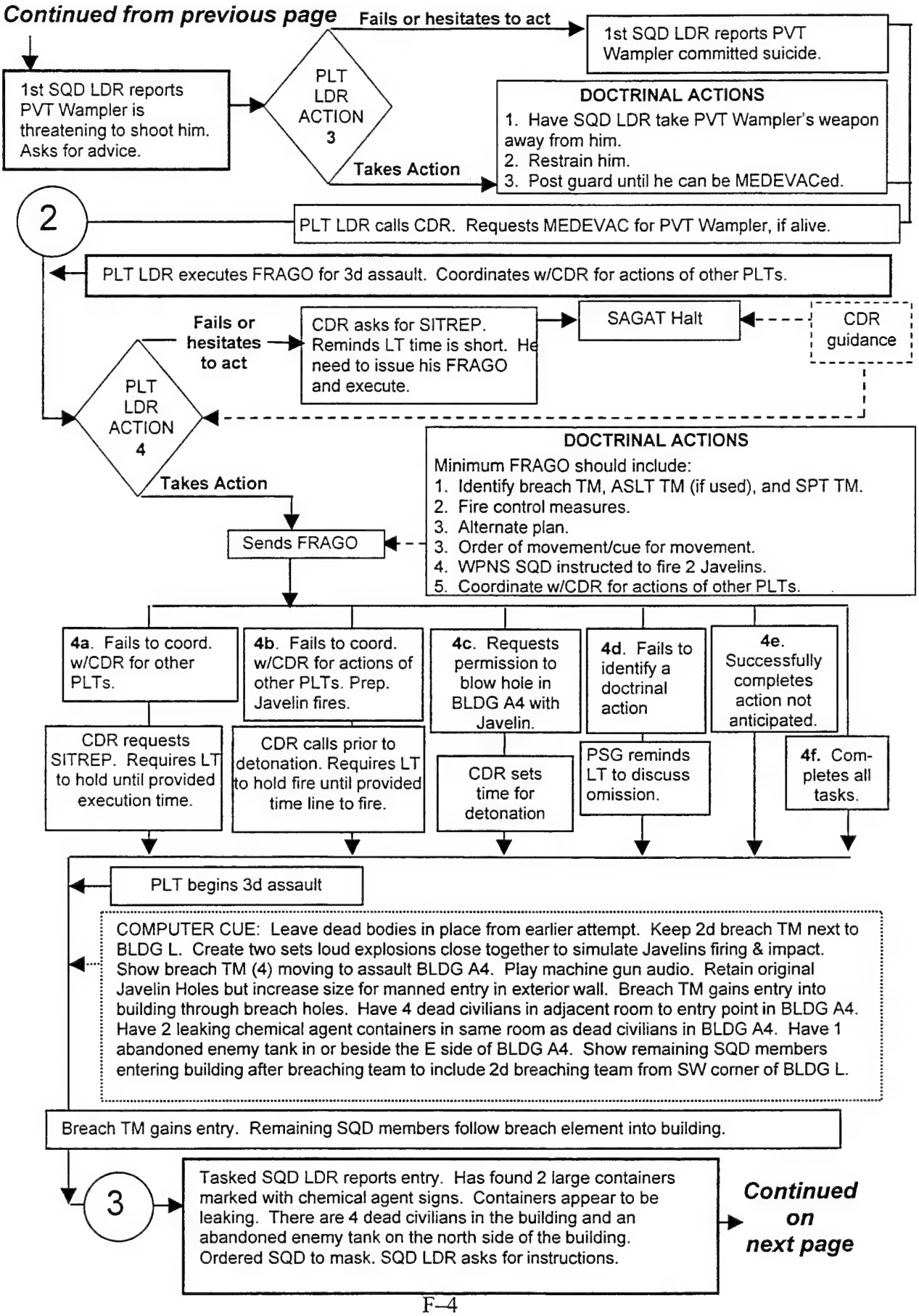
7. What are your questions?

8. The scenario will begin when you occupy the vantage point in BLDG L.

SET-UP
1. Enemy machine gun in NE corner of BLDG P2 orientated NW to N.
2. Need 1 small hole blown in N side of BLDG A4 (see computer cue).
3. Need second hole blown adjacent to 1st hole. The combination of the two will make a hole large enough for soldiers to enter the BLDG (see computer cue).
4. Need machine gun audio 2 times (see computer cue and scenario for effectiveness).
5. Need 4 dead civilians ***in*** BLDG A4 w/marked chemical containers located on the floor, in adjacent room to the (entry point). Need abandoned enemy tank ***in*** or beside the east side of BLDG A4.




Continued from previous page
1
CDR states 1st & 3d PLTs reporting heavy enemy resistance. Tells 3d PLT LDR to suppress MG in BLDG P2. 1st & 2d PLTs to again assault BLDGs E and A4, respectively. Don't hesitate in street - Blow entries w/Javelins. Wants PLT LDRs to let him know when ready so he can coordinate w/other PLTs.
SAGAT Halt
1. CDR asks for SITREP.
2. CDR again asks for SITREP.
3. CDR repeats order.
Fails or hesitates to act
PLT LDR ACTION 2
CDR guidance
DOCTRINAL ACTIONS
1. PLT LDR issues FRAGO for 2d assault.
2. Coordinates actions of other PLTs with CDR.
Takes Action
AAR NOTE: Minimum FRAGO should include identification of breach TM, PLT (-) provides suppression fires, order of movement, WPNS SQD instructed to fire Javelin. Backup plan. Coordinate w/CDR for actions of other PLT.
2a. Fails to coordinate w/CDR for actions of other PLTs.
2b. FRAGO does not discuss ID of breach TM, PLT (-) provides suppression fires, order of movement, WPNS SQD instructed to fire Javelin.
2c. Successfully completes task not anticipated.
2d. Completes all tasks.
CDR asks for SITREP. Reminds LT to call when ready so he can coordinate 1st and 3d PLT fires
PSG reminds LT to discuss omitted portion.
COMPUTER CUE: Leave dead bodies in place. Create two loud explosions to simulate Javelin firing & impact. Show breach TM (4 personnel) moving to assault BLDG A4. Play machine gun audio. Javelin hole not large enough for manned entry in exterior wall. Entry fails, breach TM survives but moves to road at SW corner of BLDG L between BLDGs L and J2.
PLT begins 2d assault
Assault fails to gain an entry. Breach force survives, but is hiding at corner of BLDG L.
In event PLT LDR fails to see assault, PSG reports the assault failed to gain an entry. Breach force has survived, but is hiding in the alley between BLDGs L & J2. SQD LDR is with breach TM. Has commo with PLT.
CDR asks for SITREP. States 1st PLT LDR reports lost all of his breach force. Orders 2d PLT to assault again. Use another Javelin to create breach. 3d PLT will support by fire.
PLT LDR issues FRAGO about another assault. Coordinates actions of other PLTs with CDR.
1st SQD LDR reports PVT Wampler is threatening to shoot him. Asks for advice.
Legend
Options
Cues
Critical Input
Decision Point
Event/Action
SAGAT Halt
Continued on next page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Fails or hesitates to act
1st SQD LDR reports PVT Wampler committed suicide.
1st SQD LDR reports PVT Wampler is threatening to shoot him. Asks for advice.
PLT LDR ACTION 3
Takes Action
DOCTRINAL ACTIONS
1. Have SQD LDR take PVT Wampler's weapon away from him.
2. Restrain him.
3. Post guard until he can be MEDEVACed.
2
PLT LDR calls CDR. Requests MEDEVAC for PVT Wampler, if alive.
PLT LDR executes FRAGO for 3d assault. Coordinates w/CDR for actions of other PLTs.
Fails or hesitates to act
CDR asks for SITREP. Reminds LT time is short. He need to issue his FRAGO and execute.
SAGAT Halt
CDR guidance
PLT LDR ACTION 4
Takes Action
DOCTRINAL ACTIONS
Minimum FRAGO should include:
1. Identify breach TM, ASLT TM (if used), and SPT TM.
2. Fire control measures.
3. Alternate plan.
3. Order of movement/cue for movement.
4. WPNS SQD instructed to fire 2 Javelins.
5. Coordinate w/CDR for actions of other PLTs.
Sends FRAGO
4a. Fails to coord. w/CDR for other PLTs.
4b. Fails to coord. w/CDR for actions of other PLTs. Prep. Javelin fires.
4c. Requests permission to blow hole in BLDG A4 with Javelin.
4d. Fails to identify a doctrinal action
4e. Successfully completes action not anticipated.
CDR requests SITREP. Requires LT to hold until provided execution time.
CDR calls prior to detonation. Requires LT to hold fire until provided time line to fire.
CDR sets time for detonation
PSG reminds LT to discuss omission.
4f. Completes all tasks.
PLT begins 3d assault
COMPUTER CUE: Leave dead bodies in place from earlier attempt. Keep 2d breach TM next to BLDG L. Create two sets loud explosions close together to simulate Javelins firing & impact. Show breach TM (4) moving to assault BLDG A4. Play machine gun audio. Retain original Javelin Holes but increase size for manned entry in exterior wall. Breach TM gains entry into building through breach holes. Have 4 dead civilians in adjacent room to entry point in BLDG A4. Have 2 leaking chemical agent containers in same room as dead civilians in BLDG A4. Have 1 abandoned enemy tank in or beside the E side of BLDG A4. Show remaining SQD members entering building after breaching team to include 2d breaching team from SW corner of BLDG L.
Breach TM gains entry. Remaining SQD members follow breach element into building.
3
Tasked SQD LDR reports entry. Has found 2 large containers marked with chemical agent signs. Containers appear to be leaking. There are 4 dead civilians in the building and an abandoned enemy tank on the north side of the building. Ordered SQD to mask. SQD LDR asks for instructions.
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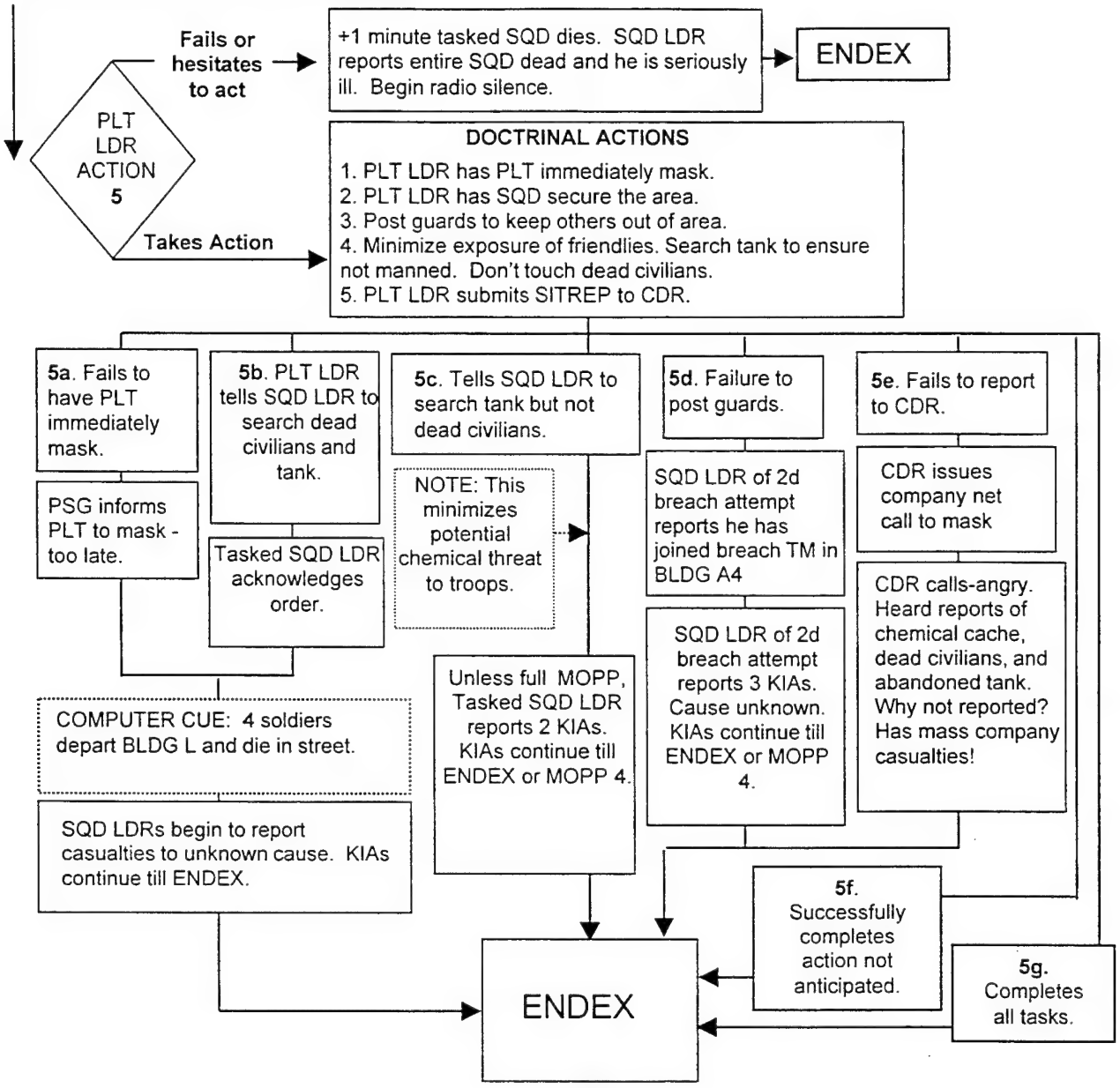


Appendix G: Defend Scenario Flow Chart

Scenario C: Defend Town, 2d PLT Mission

1. Co A, 1-11th Infantry is in the first day of occupying the town of Kenna. The company has the mission to defend the town. The enemy presence is considered light, capable of conducting military operations in the immediate region with forces less than company-size, supported by mortars. There is no heavy threat. Last reported enemy activity in the region was a platoon-sized raid conducted in the neighboring town of Polo, 3 kilometers to the northwest, 2 nights ago. The town population of Kenna is considered to be friendly. However, there may be insurgents and insurgent sympathizers within the town's population.

2. The company has established a defensive perimeter with 1st Platoon defending in the southeast quadrant of the town from BLDGs P5, P2, and A1. Your platoon, the 2d Platoon, defends the southwest quadrant of the town from BLDGs Ia-Id, Ea, and P3. 3d PLT defends the northwest quadrant from BLDGs H, G, and J1. Company A Mortars defends the northeast quadrant from BLDGs P1 and P4. The company CP is located in the north side BLDG A4.

3. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3d Squad to take advantage of the height of Building Id. There are no attachments to the platoon.

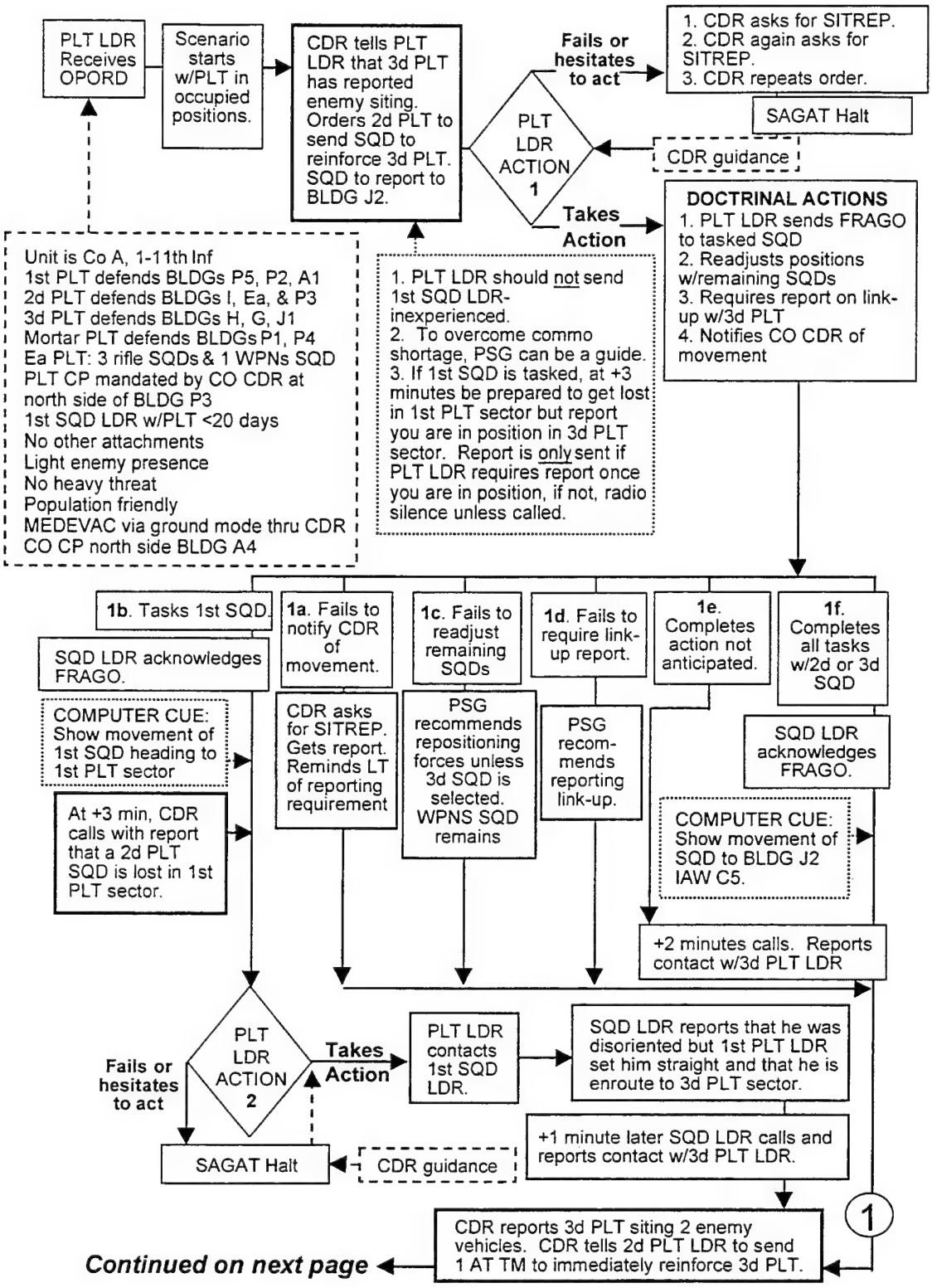
4. The 2d Platoon has been in position for 6 hours. The squads are positioned as shown in the accompanying graphic. The company commander selected the north side of BLDG P3 for the 2d Platoon CP. He has directed that all platoon leaders remain in the general vicinity of their respective CPs for communications purposes. He has directed that the platoons use their platoon sergeants as much as possible to realign positions, if necessary.

5. Ration cycle is C, C, A. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.

6. Rules of Engagement (ROE). Since the overall town population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except in self-defense or in defense of the town against a confirmed enemy presence. Self-defense is defined as a serious threat to life or limb. A serious threat is considered gunfire or the presence of an uncontrolled mob armed with life-threatening weapons such as knives, pikes, metal poles, etc. Every effort must be made to disarm the situation prior to the use of deadly force. Weapons control status is white.

7. Your immediate task is to brief your squad leaders as to the current situation.

8. What are your questions?



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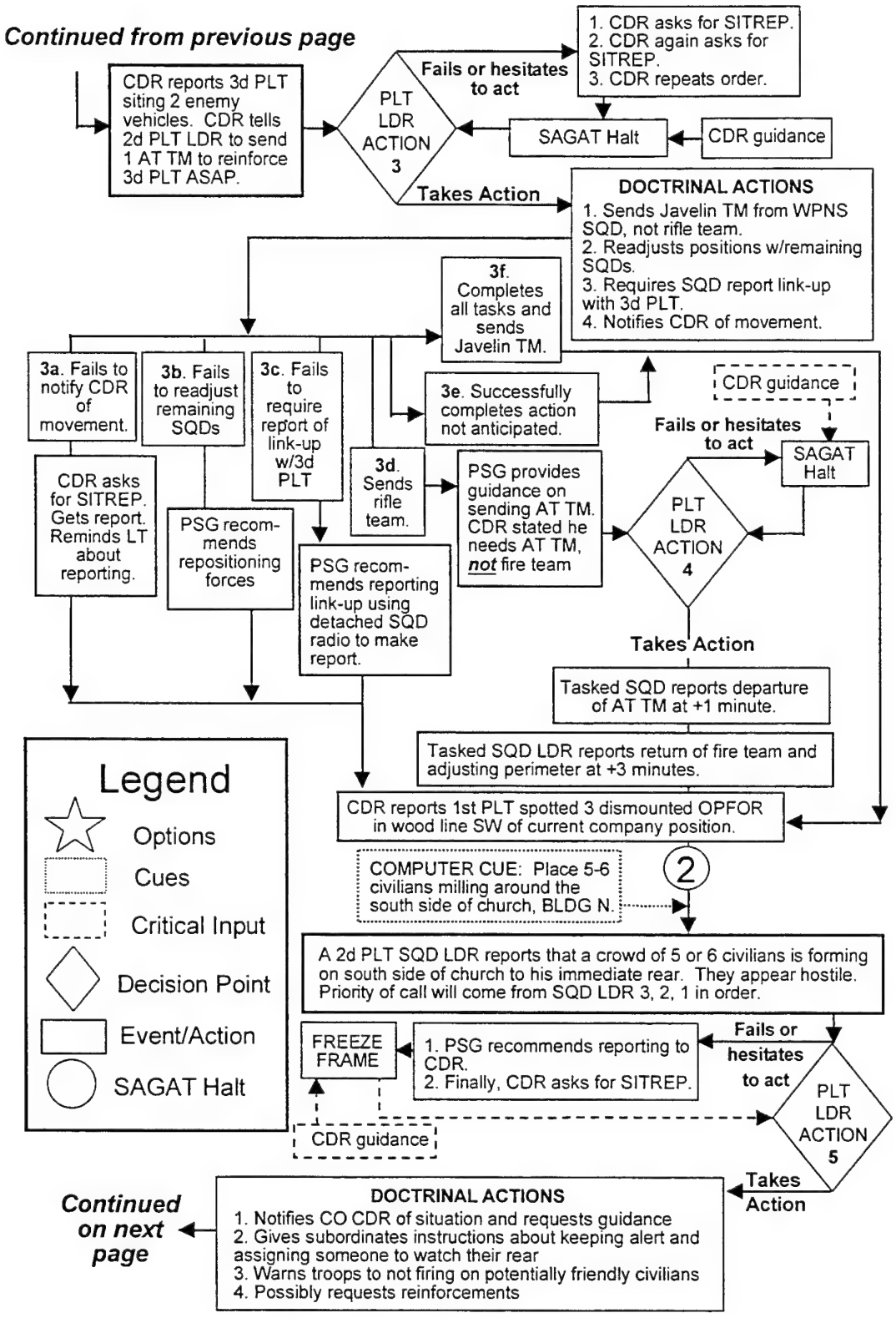
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CDR reports 3d PLT siting 2 enemy vehicles. CDR tells 2d PLT LDR to send 1 AT TM to reinforce 3d PLT ASAP.
PLT LDR ACTION 3
Fails or hesitates to act
1. CDR asks for SITREP.
2. CDR again asks for SITREP.
3. CDR repeats order.
SAGAT Halt
CDR guidance
Takes Action
DOCTRINAL ACTIONS
1. Sends Javelin TM from WPNS SQD, not rifle team.
2. Readjusts positions w/remaining SQDs.
3. Requires SQD report link-up with 3d PLT.
4. Notifies CDR of movement.
3f. Completes all tasks and sends Javelin TM.
3a. Fails to notify CDR of movement.
3b. Fails to readjust remaining SQDs
3c. Fails to require report of link-up w/3d PLT
3e. Successfully completes action not anticipated.
CDR guidance
Fails or hesitates to act
SAGAT Halt
3d. Sends rifle team.
PSG provides guidance on sending AT TM. CDR stated he needs AT TM, not fire team
PLT LDR ACTION 4
CDR asks for SITREP. Gets report. Reminds LT about reporting.
PSG recommends repositioning forces
PSG recommends reporting link-up using detached SQD radio to make report.
Takes Action
Tasked SQD reports departure of AT TM at +1 minute.
Tasked SQD LDR reports return of fire team and adjusting perimeter at +3 minutes.
CDR reports 1st PLT spotted 3 dismounted OPFOR in wood line SW of current company position.
COMPUTER CUE: Place 5-6 civilians milling around the south side of church, BLDG N.
2
A 2d PLT SQD LDR reports that a crowd of 5 or 6 civilians is forming on south side of church to his immediate rear. They appear hostile. Priority of call will come from SQD LDR 3, 2, 1 in order.
Fails or hesitates to act
FREEZE FRAME
1. PSG recommends reporting to CDR.
2. Finally, CDR asks for SITREP.
PLT LDR ACTION 5
CDR guidance
Takes Action
DOCTRINAL ACTIONS
1. Notifies CO CDR of situation and requests guidance
2. Gives subordinates instructions about keeping alert and assigning someone to watch their rear
3. Warns troops to not firing on potentially friendly civilians
4. Possibly requests reinforcements
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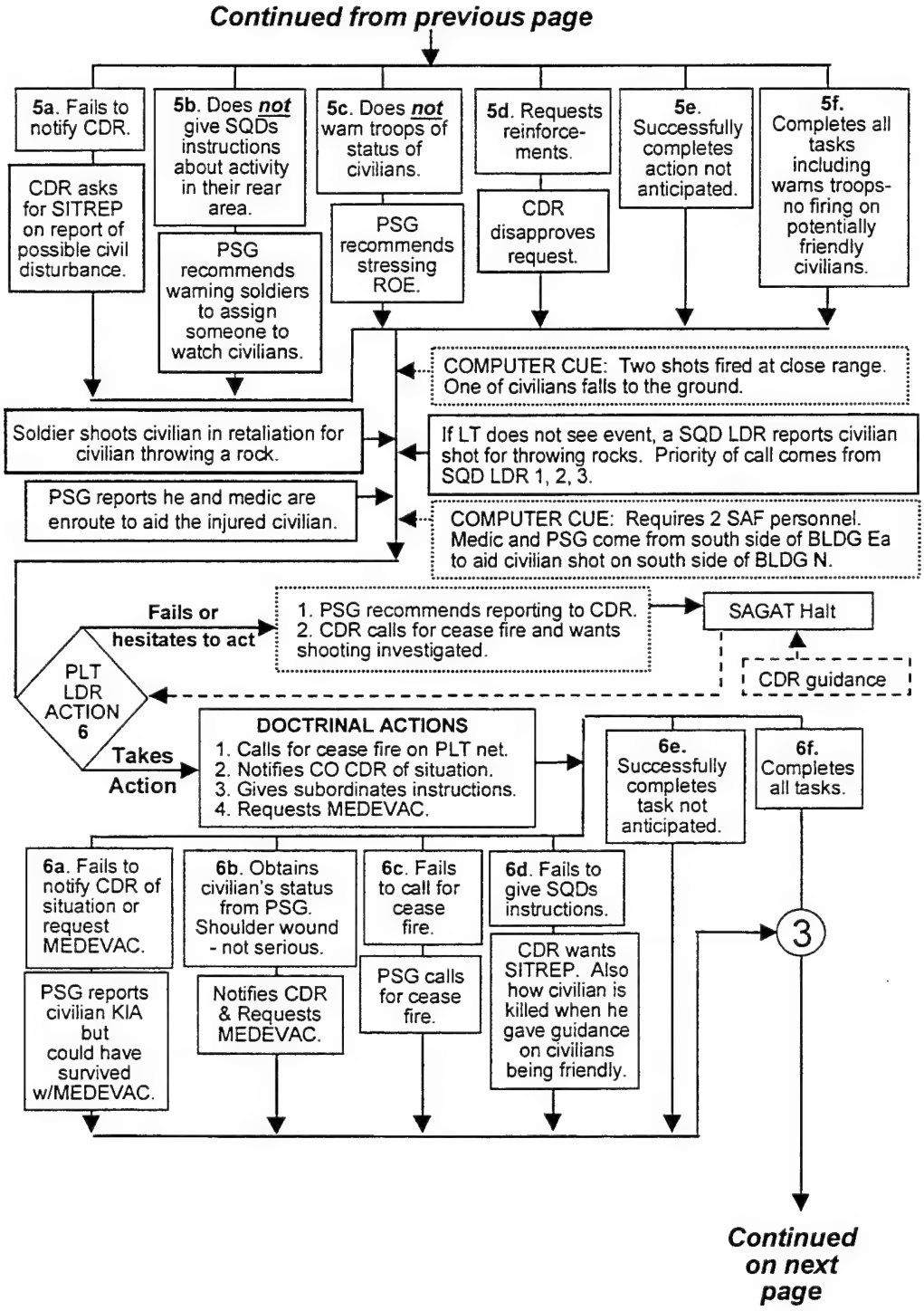
Legend
Options
Cues
Critical Input
Decision Point
Event/Action
SAGAT Halt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5a. Fails to notify CDR.
5b. Does not give SQDs instructions about activity in their rear area.
5c. Does not warn troops of status of civilians.
5d. Requests reinforce-ments.
5e. Successfully completes action not anticipated.
5f. Completes all tasks including warns troops-no firing on potentially friendly civilians.
CDR asks for SITREP on report of possible civil disturbance.
PSG recommends warning soldiers to assign someone to watch civilians.
PSG recommends stressing ROE.
CDR disapproves request.
COMPUTER CUE: Two shots fired at close range. One of civilians falls to the ground.
Soldier shoots civilian in retaliation for civilian throwing a rock.
If LT does not see event, a SQD LDR reports civilian shot for throwing rocks. Priority of call comes from SQD LDR 1, 2, 3.
PSG reports he and medic are enroute to aid the injured civilian.
COMPUTER CUE: Requires 2 SAF personnel. Medic and PSG come from south side of BLDG Ea to aid civilian shot on south side of BLDG N.
Fails or hesitates to act
1. PSG recommends reporting to CDR.
2. CDR calls for cease fire and wants shooting investigated.
SAGAT Halt
CDR guidance
PLT LDR ACTION 6
Takes Action
DOCTRINAL ACTIONS
1. Calls for cease fire on PLT net.
2. Notifies CO CDR of situation.
3. Gives subordinates instructions.
4. Requests MEDEVAC.
6e. Successfully completes task not anticipated.
6f. Completes all tasks.
6a. Fails to notify CDR of situation or request MEDEVAC.
6b. Obtains civilian's status from PSG. Shoulder wound - not serious.
6c. Fails to call for cease fire.
6d. Fails to give SQDs instructions.
PSG reports civilian KIA but could have survived w/MEDEVAC.
Notifies CDR & Requests MEDEVAC.
PSG calls for cease fire.
CDR wants SITREP. Also how civilian is killed when he gave guidance on civilians being friendly.
3
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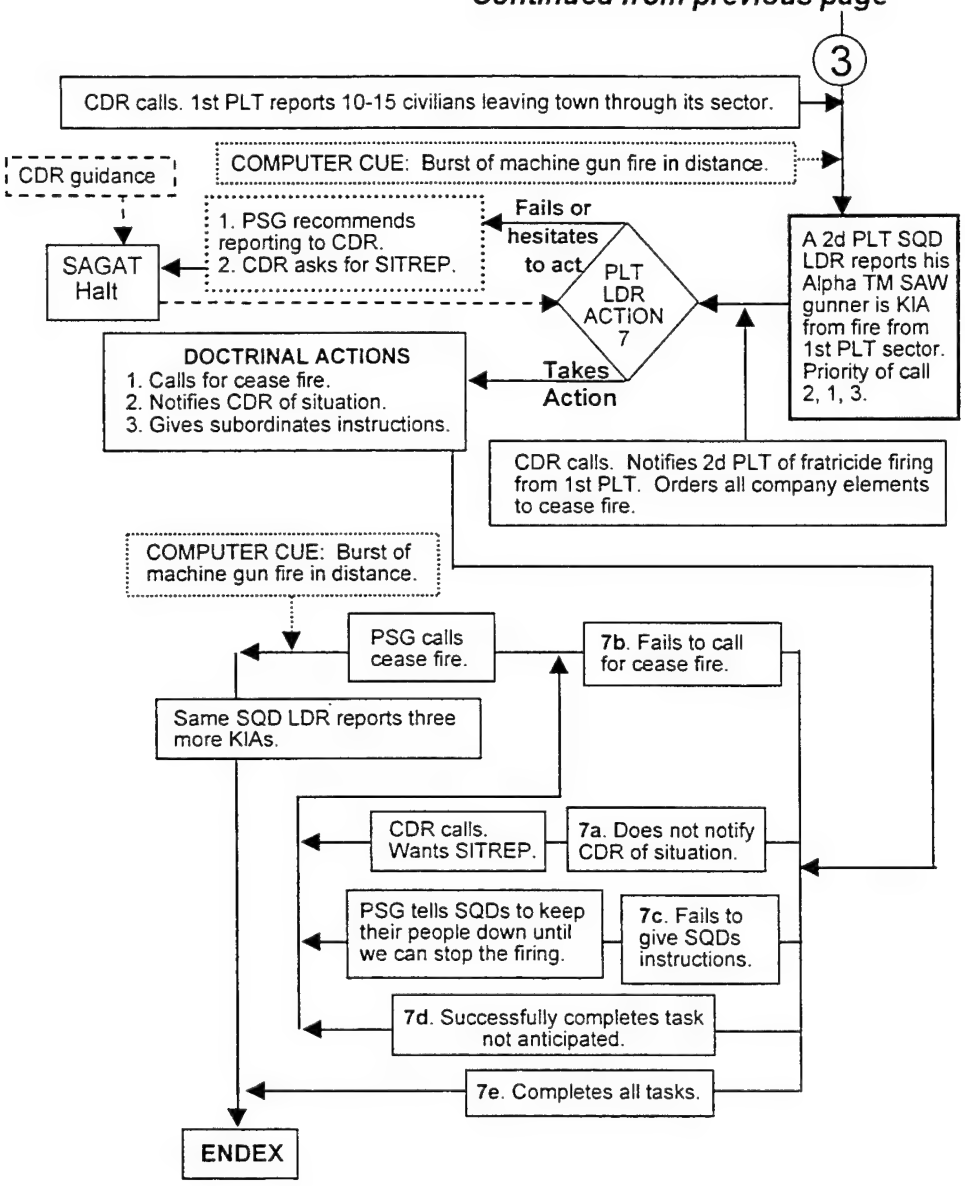

Appendix H: Data Analysis Results

Table H-1. Anova Table for Enemy Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**3991.059**	**3991.059**	**4.809**	**0.032**
Scenario	1	101.264	101.264	0.122	0.728
Halt	2	949.122	474.561	0.572	0.567
Experience * Scenario	1	15.962	15.962	0.019	0.890
Experience * Halt	2	37.466	18.733	0.023	0.978
Scenario * Halt	2	4720.104	2360.052	2.844	0.065
Experience * Scenario * Halt	2	142.150	71.075	0.086	0.918
Residual	69	57265.829	829.940		

Table H-2. Table of Means for Enemy Location

	Mean
Experienced, Assault, 1	69.347
Experienced, Assault, 2	58.127
Experienced, Assault, 3	60.154
Experienced, Defend, 1	44.880
Experienced, Defend, 2	64.751
Experienced, Defend, 3	73.943
Novice, Assault, 1	54.725
Novice, Assault, 2	49.362
Novice, Assault, 3	44.000
Novice, Defend, 1	33.660
Novice, Defend, 2	46.907
Novice, Defend, 3	58.127

Table H-3. Anova Table for Own Platoon Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**277.754**	**277.754**	**5.190**	**0.026**
Scenario	1	18.390	18.390	0.344	0.560
Halt	2	220.808	110.404	2.063	0.135
Experience * Scenario	1	156.226	156.226	2.919	0.092
Experience * Halt	2	117.075	58.537	1.094	0.341
Scenario * Halt	2	73.749	36.874	0.689	0.506
Experience * Scenario * Halt	2	224.197	112.098	2.095	0.131
Residual	69	3692.499	53.514		

Table H-4. Table of Means for Own Platoon Location

	Mean
Experienced, Assault, 1	75.378
Experienced, Assault, 2	68.717
Experienced, Assault, 3	73.797
Experienced, Defend, 1	78.540
Experienced, Defend, 2	74.846
Experienced, Defend, 3	69.993
Novice, Assault, 1	74.851
Novice, Assault, 2	72.613
Novice, Assault, 3	67.644
Novice, Defend, 1	66.404
Novice, Defend, 2	69.922
Novice, Defend, 3	67.566

Table H-5. Anova Table for Friendly Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	732.506	732.506	1.103	0.297
Scenario	**1**	**4737.692**	**4737.692**	**7.134**	**0.009**
Halt	2	400.877	200.439	0.302	0.740
Experience * Scenario	1	2127.708	2127.708	3.204	0.078
Experience * Halt	2	157.374	78.687	0.118	0.888
Scenario * Halt	2	1021.989	510.995	0.769	0.467
Experience * Scenario * Halt	2	472.124	236.062	0.355	0.702
Residual	69	45823.548	664.109		

Table H-6. Table of Means for Friendly Location

	Mean
Experienced, Assault, 1	40.028
Experienced, Assault, 2	56.834
Experienced, Assault, 3	44.620
Experienced, Defend, 1	40.358
Experienced, Defend, 2	35.321
Experienced, Defend, 3	50.632
Novice, Assault, 1	63.075
Novice, Assault, 2	63.075
Novice, Assault, 3	64.235
Novice, Defend, 1	36.548
Novice, Defend, 2	34.690
Novice, Defend, 3	42.338

Table H-7. Anova Table for Total Elements Located

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	66.796	66.796	0.440	0.509
Scenario	**1**	**2299.593**	**2299.593**	**15.151**	**<0.001**
Halt	2	41.967	20.983	0.138	0.871
Experience * Scenario	1	241.930	241.930	1.594	0.211
Experience * Halt	2	18.225	9.112	0.060	0.942
Scenario * Halt	2	229.871	114.936	0.757	0.473
Experience * Scenario * Halt	2	56.010	28.005	0.185	0.832
Residual	69	10472.702	151.778		

Table H-8. Table of Means for Total Elements Located

	Mean
Experienced, Assault, 1	65.870
Experienced, Assault, 2	63.965
Experienced, Assault, 3	63.965
Experienced, Defend, 1	56.427
Experienced, Defend, 2	57.036
Experienced, Defend, 3	58.688
Novice, Assault, 1	68.704
Novice, Assault, 2	65.094
Novice, Assault, 3	64.933
Novice, Defend, 1	48.158
Novice, Defend, 2	51.428
Novice, Defend, 3	56.711

Table H-9. Anova Table for Highest Threat

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**12200.906**	**12200.906**	**9.362**	**0.003**
Scenario	1	3008.755	3008.755	2.309	0.133
Halt	2	371.754	185.877	0.143	0.867
Experience * Scenario	1	23.108	23.108	0.018	0.895
Experience * Halt	2	2076.151	1038.075	0.797	0.455
Scenario * Halt	2	3095.797	1547.899	1.188	0.311
Experience * Scenario * Halt	2	2751.750	1375.875	1.056	0.354
Residual	68	88617.560	1303.199		

Table H-10. Table of Means for Highest Threat

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	44.880
Experience, Defend, 1	44.880
Experience, Defend, 2	56.100
Experience, Defend, 3	67.320
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	52.360
Novice, Defend, 1	22.440
Novice, Defend, 2	29.063
Novice, Defend, 3	39.270

Table H-11. Anova Table for Weakest Enemy

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	440.816	440.816	0.347	0.558
Scenario	**1**	**14823.240**	**14823.240**	**11.666**	**0.001**
Halt	2	3947.675	1973.838	1.553	0.219
Experience * Scenario	1	17.666	17.666	0.014	0.907
Experience * Halt	2	1691.432	845.716	0.666	0.517
Scenario * Halt	2	6767.729	3383.864	2.663	0.077
Experience * Scenario * Halt	2	2256.577	1128.288	0.888	0.416
Residual	69	87675.650	1270.662		

Table H-12. Table of Means for Weakest Enemy

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	22.440
Experience, Assault, 3	22.440
Experience, Defend, 1	67.320
Experience, Defend, 2	33.660
Experience, Defend, 3	33.660
Novice, Assault, 1	13.090
Novice, Assault, 2	13.090
Novice, Assault, 3	13.083
Novice, Defend, 1	56.100
Novice, Defend, 2	11.220
Novice, Defend, 3	56.100

Table H-13. Anova Table for Strongest Enemy

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**11915.107**	**11915.107**	**9.361**	**0.003**
Scenario	1	70.414	70.414	0.055	0.815
Halt	2	1139.829	569.915	0.448	0.641
Experience * Scenario	1	3454.945	3454.945	2.714	0.104
Experience * Halt	2	857.340	428.670	0.337	0.715
Scenario * Halt	**2**	**16368.887**	**8184.443**	**6.430**	**0.003**
Experience * Scenario * Halt	2	857.340	428.670	0.337	0.715
Residual	69	87822.519	1272.790		

Table H-14. Table of Means for Strongest Enemy

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	33.660
Experience, Defend, 1	33.660
Experience, Defend, 2	44.880
Experience, Defend, 3	67.320
Novice, Assault, 1	26.180
Novice, Assault, 2	39.270
Novice, Assault, 3	13.083
Novice, Defend, 1	22.440
Novice, Defend, 2	33.660
Novice, Defend, 3	56.100

Table H-15. Anova Table for Weakest Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	580.283	580.283	0.381	0.539
Scenario	1	4053.395	4053.395	2.662	0.108
Halt	2	622.439	311.220	0.204	0.816
Experience * Scenario	1	1641.337	1641.337	1.078	0.303
Experience * Halt	2	920.574	460.287	0.302	0.740
Scenario * Halt	2	7824.712	3912.356	2.570	0.084
Experience * Scenario * Halt	2	936.467	468.233	0.308	0.736
Residual	66	100486.018	1522.515		

Table H-16. Table of Means for Weakest Friendly

	Mean
Experience, Assault, 1	52.360
Experience, Assault, 2	26.180
Experience, Assault, 3	44.880
Experience, Defend, 1	11.220
Experience, Defend, 2	51.503
Experience, Defend, 3	44.880
Novice, Assault, 1	62.832
Novice, Assault, 2	52.360
Novice, Assault, 3	52.360
Novice, Defend, 1	22.440
Novice, Defend, 2	44.880
Novice, Defend, 3	29.063

Table H-17. Anova Table for Strongest Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**4537.133**	**4537.133**	**6.504**	**0.013**
Scenario	**1**	**8812.172**	**8812.172**	**12.633**	**0.001**
Halt	2	1115.704	557.852	0.800	0.454
Experience * Scenario	1	286.450	286.450	0.411	0.524
Experience * Halt	2	536.748	268.374	0.385	0.682
Scenario * Halt	2	1861.895	930.948	1.335	0.270
Experience * Scenario * Halt	2	1489.227	744.613	1.067	0.350
Residual	65	45342.033	697.570		

Table H-18. Table of Means for Strongest Friendly

	Mean
Experience, Assault, 1	54.725
Experience, Assault, 2	28.545
Experience, Assault, 3	65.450
Experience, Defend, 1	33.118
Experience, Defend, 2	35.678
Experience, Defend, 3	27.024
Novice, Assault, 1	73.177
Novice, Assault, 2	65.670
Novice, Assault, 3	67.815
Novice, Defend, 1	45.870
Novice, Defend, 2	42.311
Novice, Defend, 3	42.311

Table H-19. Anova Table for Exposed Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	1022.286	1022.286	0.817	0.369
Scenario	**1**	**28293.562**	**28293.562**	**22.625**	**<.0001**
Halt	2	1012.748	506.374	0.405	0.669
Experience * Scenario	1	233.831	233.831	0.187	0.667
Experience * Halt	2	349.892	174.946	0.140	0.870
Scenario * Halt	2	5634.433	2817.217	2.253	0.113
Experience * Scenario * Halt	2	1012.748	506.374	0.405	0.669
Residual	68	85037.216	1250.547		

Table H-20. Table of Means for Exposed Friendly

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	0.000
Experience, Assault, 3	22.440
Experience, Defend, 1	67.320
Experience, Defend, 2	56.100
Experience, Defend, 3	33.660
Novice, Assault, 1	26.180
Novice, Assault, 2	13.090
Novice, Assault, 3	26.180
Novice, Defend, 1	56.100
Novice, Defend, 2	67.320
Novice, Defend, 3	44.880

Table H-21. Anova Table for My Location Known

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	634.475	634.475	1.553	0.217
Scenario	**1**	**3454.362**	**3454.362**	**8.453**	**0.005**
Halt	**2**	**2678.893**	**1339.446**	**3.278**	**0.044**
Experience * Scenario	1	634.475	634.475	1.553	0.217
Experience * Halt	2	422.983	211.492	0.518	0.598
Scenario * Halt	**2**	**2678.893**	**1339.446**	**3.278**	**0.044**
Experience * Scenario * Halt	2	422.983	211.492	0.518	0.598
Residual	69	28198.870	408.679		

Table H-22. Table of Means for My Location Known

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	78.540
Experience, Defend, 1	78.540
Experience, Defend, 2	78.540
Experience, Defend, 3	56.100
Novice, Assault, 1	78.540
Novice, Assault, 2	78.540
Novice, Assault, 3	78.540
Novice, Defend, 1	78.540
Novice, Defend, 2	56.100
Novice, Defend, 3	44.880

Table H-23. Anova Table for Number of Casualties

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	158.619	158.619	0.197	0.659
Scenario	**1**	**26806.551**	**26806.551**	**33.229**	**<.0001**
Halt	2	505.230	252.615	0.313	0.732
Experience * Scenario	1	158.619	158.619	0.197	0.659
Experience * Halt	2	1492.190	746.095	0.925	0.401
Scenario * Halt	2	505.230	252.615	0.313	0.732
Experience * Scenario * Halt	2	1492.190	746.095	0.925	0.401
Residual	69	55663.394	806.716		

Table H-24. Table of Means for Number of Casualties

	Mean
Experience, Assault, 1	44.880
Experience, Assault, 2	33.660
Experience, Assault, 3	56.100
Experience, Defend, 1	78.540
Experience, Defend, 2	78.540
Experience, Defend, 3	78.540
Novice, Assault, 1	26.180
Novice, Assault, 2	52.360
Novice, Assault, 3	39.270
Novice, Defend, 1	78.540
Novice, Defend, 2	78.540
Novice, Defend, 3	78.540

Table H-25. Anova Table for Next Enemy Action

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	7.094	7.094	0.009	0.924
Scenario	**1**	**25965.910**	**25965.910**	**33.217**	**<.0001**
Halt	**2**	**21189.457**	**10594.729**	**13.553**	**<.0001**
Experience * Scenario	1	1120.920	1120.920	1.434	0.235
Experience * Halt	2	1741.582	870.791	1.114	0.334
Scenario * Halt	**2**	**12480.671**	**6240.335**	**7.983**	**0.001**
Experience * Scenario * Halt	2	1463.845	731.923	0.936	0.397
Residual	68	53155.398	781.697		

Table H-26. Table of Means for Next Enemy Action

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	11.220
Experience, Defend, 1	26.180
Experience, Defend, 2	11.220
Experience, Defend, 3	0.000
Novice, Assault, 1	78.540
Novice, Assault, 2	52.360
Novice, Assault, 3	13.090
Novice, Defend, 1	17.844
Novice, Defend, 2	17.844
Novice, Defend, 3	22.440

Table H-27. Anova Table for Next Civilian Action

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	4143.667	4143.667	3.051	0.085
Scenario	1	1323.780	1323.780	0.975	0.327
Halt	**2**	**13022.395**	**6511.197**	**4.795**	**0.011**
Experience * Scenario	1	195.825	195.825	0.144	0.705
Experience * Halt	2	426.900	213.450	0.157	0.855
Scenario * Halt	**2**	**10578.493**	**5289.246**	**3.895**	**0.025**
Experience * Scenario * Halt	2	426.900	213.450	0.157	0.855
Residual	69	93702.494	1358.007		

Table H-28. Table of Means for Next Civilian Action

	Mean
Experience, Assault, 1	56.100
Experience, Assault, 2	56.100
Experience, Assault, 3	44.880
Experience, Defend, 1	78.540
Experience, Defend, 2	11.220
Experience, Defend, 3	33.660
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	26.180
Novice, Defend, 1	56.100
Novice, Defend, 2	11.220
Novice, Defend, 3	22.440

Table H-29. Anova Table for Advantage

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	565.936	565.936	0.417	0.520
Scenario	1	565.936	565.936	0.417	0.520
Halt	2	3399.530	1699.765	1.254	0.292
Experience * Scenario	1	3620.813	3620.813	2.670	0.107
Experience * Halt	2	203.659	101.829	0.075	0.928
Scenario * Halt	2	2177.579	1088.790	0.803	0.452
Experience * Scenario * Halt	2	109.662	54.831	0.040	0.960
Residual	69	93555.625	1355.879		

Table H-30. Table of Means for Advantage

	Mean
Experience, Assault, 1	56.100
Experience, Assault, 2	56.100
Experience, Assault, 3	33.660
Experience, Defend, 1	67.320
Experience, Defend, 2	67.320
Experience, Defend, 3	67.320
Novice, Assault, 1	65.450
Novice, Assault, 2	65.450
Novice, Assault, 3	39.270
Novice, Defend, 1	56.100
Novice, Defend, 2	44.880
Novice, Defend, 3	44.880

Table H-31. Anova Table for Not in Communication

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	1810.630	1810.630	1.563	0.215
Scenario	1	103.115	103.115	0.089	0.766
Halt	2	1488.758	744.379	0.643	0.529
Experience * Scenario	**1**	**6954.292**	**6954.292**	**6.005**	**0.017**
Experience * Halt	2	132.434	66.217	0.057	0.945
Scenario * Halt	2	1488.758	744.379	0.643	0.529
Experience * Scenario * Halt	2	132.434	66.217	0.057	0.945
Residual	69	79908.919	1158.100		

Table H-32. Table of Means for Not in Communication

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	11.220
Experience, Assault, 3	11.220
Experience, Defend, 1	29.063
Experience, Defend, 2	13.247
Experience, Defend, 3	40.283
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	39.270
Novice, Defend, 1	17.844
Novice, Defend, 2	11.216
Novice, Defend, 3	26.247

Table H-33. SABARS Factor Analysis – Factor Loadings

	Factor 1-Gathering Information	Factor 2–Focusing Out Vs In	Factor 3–Seeking Key Information	Factor 4–Focusing on Big Picture
Alert Level	0.653	-0.037	-0.072	0.160
SL Info	0.037	-0.778	0.020	0.250
CO Info	-0.178	0.274	0.440	0.588
Commo to CO	0.248	0.751	0.185	0.304
Commo to SL	0.176	0.040	0.212	0.634
Monitors net	0.567	0.208	-0.174	0.489
Assess Info	0.603	0.173	0.388	0.267
Intel requested	<.001	0.576	0.256	0.337
Intel gathered	-0.027	-0.129	0.824	-0.118
Give CI & big pic	0.131	-0.167	-0.027	0.605
Uses SRP	0.825	0.187	-0.197	0.264
Ids Critical tasks	-0.038	-0.817	0.011	0.077
Cover Approach	-0.170	-0.105	0.629	0.215
Vantage Pt	0.117	0.183	0.629	0.062
Asset recon	0.862	<.001	0.169	-0.004
OCOKA	0.695	-0.037	0.329	-0.264
Key finds	0.339	0.405	0.603	0.205
Key info-reports	0.246	0.403	0.654	0.175
Follow up info	0.611	0.605	0.051	<.001
Overall SA	0.547	0.249	0.558	-0.009

** all items with loadings > .30 included in combined factor score*

Table H-34. SABARS Factor Analysis -Eigenvalues and percent of variance accounted for by factors

Eigenvalues

	Magnitude	Variance Prop.
Factor 1 - Gathering Information	7.113	0.356
Factor 2 - Focusing Out Vs. In	2.361	0.118
Factor 3 - Seeking Key Information	2.32	0.116
Factor 4 - Focusing on Big Picture	1.521	0.076

Table H-35. Correlation Matrix for all SA Measures

	1-Info Gather	2-Focus Out v. In	3-Seek Key Info	4-Big Picture	PSAQ Workload	PSAQ Performance	PSAQ SA	Enemy ID
1-Info Gathering	1	0.557	0.685	0.623	-0.016	0.097	0.339	0.413
2-Focus Out v. In	0.557	1	0.368	0.56	0.304	-0.226	0.106	0.153
3-Seeks Key Info	0.685	0.368	1	0.367	0.113	0.161	0.471	0.269
4-Big Picture Focus	0.623	0.56	0.367	1	0.045	-0.085	0.001	0.558
Self-Rated Workload	-0.016	0.304	0.113	0.045	1	-0.375	-0.143	-0.287
Self -Rated Performance	0.097	-0.226	0.161	-0.085	-0.375	1	0.26	0.167
Self - Rated SA	0.339	0.106	0.471	0.001	-0.143	0.26	1	0.14
Enemies Located	0.413	0.153	0.269	0.558	-0.287	0.167	0.14	1
Own Platoon Located	0.102	0.121	0.129	0.141	0.188	0.155	0.077	0.37
Other Friendlies Located	-0.093	0.183	-0.036	0.247	0.388	-0.21	-0.027	0.263
Total Elements Located	0.032	0.262	-0.038	0.322	0.354	-0.214	-0.06	0.436
Highest Threat	0.09	-0.155	0.202	0.146	0.039	0.111	-0.074	0.453
Weakest Enemy	0.028	0.046	0.115	-0.015	-0.239	0.21	0.262	0.193
Strongest Enemy	0.282	0.081	0.299	0.334	0.2	0.166	-0.04	0.458
Weakest Friendly	-0.298	-0.088	-0.233	-0.062	0.268	0.017	-0.166	-0.003
Strongest Friendly	-0.455	-0.078	-0.464	-0.2	0.162	-0.139	-0.11	-0.199
Exposed Friendly	0.031	0.22	0.052	-0.258	-0.157	0.205	0.346	-0.344
F Location Known	-0.166	0.218	-0.255	-0.249	0.139	-0.132	-0.189	-0.215
# Casualties	0.371	0.284	0.551	0.219	-0.008	0.369	0.551	-0.122
Expected Enemy Actions	-0.124	-0.057	-0.349	0.02	0.314	-0.145	-0.37	-0.119
Expected Civilian Actions	0.255	0.314	-0.04	0.18	-0.184	-0.125	-0.004	0.276
Advantage	0.105	-0.173	0.08	0.067	-0.479	0.299	0.23	0.366
Not in Communication	-0.175	-0.07	-0.225	0.1	-0.354	0.261	-0.243	0.268

Table H-35 (continued) Correlation Matrix for all SA Measures

	Own Troop ID	Adj. Friendly ID	Total ID	Highest Threat	Weakest Enemy	Strongest Enemy	Weakest Friendly	Strongest Friendly
1-Info Gathering	0.102	-0.093	0.032	0.09	0.028	0.282	-0.298	-0.455
2-Focus Out v. In	0.121	0.183	0.262	-0.155	0.046	0.081	-0.088	-0.078
3-Seeks Key Info	0.129	-0.036	-0.038	0.202	0.115	0.299	-0.233	-0.464
4-Big Picture Focus	0.141	0.247	0.322	0.146	-0.015	0.334	-0.062	-0.2
Self-Rated Workload	0.188	0.388	0.354	0.039	-0.239	0.2	0.268	0.162
Self -Rated Performance	0.155	-0.21	-0.214	0.111	0.21	0.166	0.017	-0.139
Self - Rated SA	0.077	-0.027	-0.06	-0.074	0.262	-0.04	-0.166	-0.11
Enemies Located	0.37	0.263	0.436	0.453	0.193	0.458	-0.003	-0.199
Own Platoon Located	1	0.339	0.5	0.508	0.271	0.464	-0.139	-0.013
Other Friendlies Located	0.339	1	0.902	0.15	-0.147	0.244	-0.041	0.212
Total Elements Located	0.5	0.902	1	0.295	-0.057	0.398	-0.086	0.201
Highest Threat	0.508	0.15	0.295	1	-0.01	0.699	0.049	-0.446
Weakest Enemy	0.271	-0.147	-0.057	-0.01	1	0.268	-0.278	-0.044
Strongest Enemy	0.464	0.244	0.398	0.699	0.268	1	-0.212	-0.442
Weakest Friendly	-0.139	-0.041	-0.086	0.049	-0.278	-0.212	1	0.254
Strongest Friendly	-0.013	0.212	0.201	-0.446	-0.044	-0.442	0.254	1
Exposed Friendly	-0.276	-0.289	-0.346	-0.583	0.277	-0.323	-0.129	-0.012
F Location Known	0.103	0.052	0.119	0.05	-0.284	-0.146	0.021	0.198
# Casualties	-0.119	-0.151	-0.285	-0.204	0.312	-0.021	-0.054	-0.302
Expected Enemy Actions	-0.153	0.299	0.339	0.137	-0.676	0.027	0.293	0.245
Expected Civilian Actions	-0.22	0.123	0.217	-0.063	0.115	0.007	-0.211	0.041
Advantage	0.123	-0.186	-0.155	0.305	0.125	0.077	0.017	-0.197
Not in Communication	-0.059	0.178	0.131	-0.014	-0.094	-0.073	0.152	0.1

Table H-35 (continued) Correlation Matrix for all SA Measures

	Exposed Friendly	F Location Known	# Casualties	Next Enemy Actions	Next Civilian Actions	Advantage	Not in Communication
1-Info Gathering	0.031	-0.166	0.371	-0.124	0.255	0.105	-0.175
2-Focus Out v. In	0.22	0.218	0.284	-0.057	0.314	-0.173	-0.07
3-Seeks Key Info	0.052	-0.255	0.551	-0.349	-0.04	0.08	-0.225
4-Big Picture Focus	-0.258	-0.249	0.219	0.02	0.18	0.067	0.1
Self-Rated Workload	-0.157	0.139	-0.008	0.314	-0.184	-0.479	-0.354
Self -Rated Performance	0.205	-0.132	0.369	-0.145	-0.125	0.299	0.261
Self - Rated SA	0.346	-0.189	0.551	-0.37	-0.004	0.23	-0.243
Enemies Located	-0.344	-0.215	-0.122	-0.119	0.276	0.366	0.268
Own Platoon Located	-0.276	0.103	-0.119	-0.153	-0.22	0.123	-0.059
Other Friendlies Located	-0.289	0.052	-0.151	0.299	0.123	-0.186	0.178
Total Elements Located	-0.346	0.119	-0.285	0.339	0.217	-0.155	0.131
Highest Threat	-0.583	0.05	-0.204	0.137	-0.063	0.305	-0.014
Weakest Enemy	0.277	-0.284	0.312	-0.676	0.115	0.125	-0.094
Strongest Enemy	-0.323	-0.146	-0.021	0.027	0.007	0.077	-0.073
Weakest Friendly	-0.129	0.021	-0.054	0.293	-0.211	0.017	0.152
Strongest Friendly	-0.012	0.198	-0.302	0.245	0.041	-0.197	0.1
Exposed Friendly	1	-0.045	0.547	-0.305	-0.017	-0.069	-0.115
F Location Known	-0.045	1	-0.253	0.102	0.281	-0.201	0.085
# Casualties	0.547	-0.253	1	-0.374	-0.172	0.132	-0.214
Expected Enemy Actions	-0.305	0.102	-0.374	1	-0.007	-0.156	-0.03
Expected Civilian Actions	-0.017	0.281	-0.172	-0.007	1	-0.139	0.047
Advantage	-0.069	-0.201	0.132	-0.156	-0.139	1	0.336
Not in Communication	-0.115	0.085	-0.214	-0.03	0.047	0.336	1

Table H-36. Anova table for SABARS Factor 1 – Gathering Information

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**33.423**	**33.423**	**7.763**	**0.008**
SCENARIO	3	4.806	1.602	0.372	0.774
Experience * SCENARIO	3	15.067	5.022	1.167	0.332
Residual	48	206.650	4.305		

Table H-37. Anova Table for SABARS Factor 2 – Focusing Outward Vs. Inward

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	5.743	5.743	2.684	0.108
SCENARIO	3	0.975	0.325	0.152	0.928
Experience * SCENARIO	3	2.022	0.674	0.315	0.815
Residual	48	102.712	2.140		

Table H-38. Anova Table for SABARS Factor 3 – Proactively Seeking Key Information

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	19.091	19.091	3.411	0.071
SCENARIO	3	36.920	12.307	2.199	0.100
Experience * SCENARIO	3	19.396	6.465	1.155	0.337
Residual	48	268.635	5.597		

Table H-39. Anova Table for SABARS Factor 4 – Focusing on the Big Picture

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	**1**	**6.285**	**6.285**	**6.761**	**0.012**
SCENARIO	3	0.334	0.111	0.120	0.948
Experience * SCENARIO	3	1.502	0.501	0.538	0.658
Residual	48	44.621	0.930		

Table H-40. Anova Table for PSAQ Workload

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	2.286	2.286	2.909	0.101
Experience	1	0.143	0.143	0.182	0.674
Scenario * Experience	1	0.143	0.143	0.182	0.674
Residual	24	18.857	0.786		

Table H-41. Anova Table for PSAQ Performance

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	1.750	1.750	2.227	0.149
Experience	1	0.321	0.321	0.409	0.529
Scenario * Experience	1	0.321	0.321	0.409	0.529
Residual	24	18.857	0.786		

Table H-42. Anova Table for PSAQ SA

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	2.286	2.286	3.048	0.094
Experience	1	0.143	0.143	0.190	0.666
Scenario * Experience	1	1.286	1.286	1.714	0.203
Residual	24	18.000	0.750		

Appendix I: Acronyms

AAR – After Action Review

ANOVA – Analysis of Variance

AO – Area of Operations

CI – Commander's Intent

CO – Commanding Officer

COA – Course of Action

FOF – Field of Fire

FOO – Field of Observation

LP/OP – Listening Post/Observation Post

MOUT – Military Operations on Urbanized Terrain

NBC – Nuclear, Biological, and Chemical

NVG – Night Vision Goggles

O/C – Observer/Controller

OCOKA – Observation, Cover and Concealment, Obstacles, Key Terrain, Avenues of Approach

PSAQ – Post-Trial Participant Subjective SA Questionnaire

ROE – Rules of Engagement

SA – Situation Awareness

SABARS – Situation Awareness Behaviorally Anchored Rating Scale

SAGAT – Situation Awareness Global Assessment Technique

SART – Situation Awareness Rating Technique

SASO – Stability and Support Operations

SME – Subject Matter Expert

SSE – Squad Synthetic Environment